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AGRICULTURAL ENGINEERING

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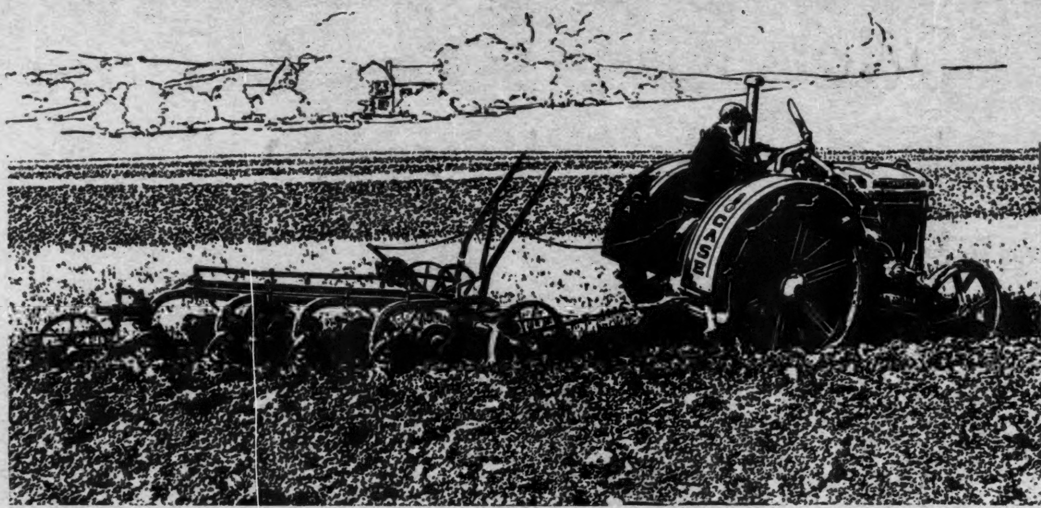

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AGRICULTURAL ENGINEERING

Vol. 9 MARCH, 1928 No. 3

The Status of Farm Equipment Research*

By H. B. Walker[1]

WHAT would you do if you were given $100,000 per annum and told to solve the equipment problems of an industry utilizing 3½ billions[2] of dollars of machinery on approximately 6½ millions of operating units scattered over 48 states of this country. I imagine you would want to analyze the situation pretty carefully before giving a definite answer. Yet that is about the situation we find ourselves in today when we attempt to put into effect a national correlated program of research in mechanical farm equipment. Really, our problem is even more complicated than that, since the available funds for the most part are represented largely by the salaries of personnel scattered among a fairly large number of state experiment stations. Evidently it is not a simple task and we can hardly expect to put even a limited program on a smooth operating basis without several years of preliminary organization work.

The most important development in research in mechanical farm equipment within the past two years has been our recognition of the need of such investigations. Not many years ago we were uncertain as to just what should be included in equipment research and few of us fully comprehended its significance, but I feel safe in saying that the survey work of the past one and one-half years has been the means of establishing farm equipment research on a basis comparable to other lines of agricultural investigations in a large number of our experiment stations. It is true the extent of these studies is yet relatively small and will remain so for some time to come because of force of circumstances, but we have completed the preliminary work of establishment, and now we must look forward to a definite procedure which will insure a maximum of results with the limited resources available.

J. B. Davidson, as director of the survey of research in mechanical farm equipment for the U.S.D.A. Division of Agricultural Engineering, working in cooperation with the advisory council to this survey, assembled a list of over 400 problems relating to farm machines. These covered a wide range of equipment as well as many general problems of basic and economic importance. R. W. Trullinger, of the U.S.D.A. Office of Experiment Stations, reported at the same time on 143 research projects under way in the various experimental stations of this country. The report of Prof. Davidson submitted in December 1926, outlined in a comprehensive manner the status of the work up to that time. Much of his work was necessarily of a pioneering nature, but his efforts were effective in opening up the way for a more intensive program this year.

It is self-evident that it would be impossible to inaugurate a research program at the outset which would develop answers to all of the 400 problems contained in the Davidson report. In fact, the solution of many of the problems submitted are dependent upon the solution of certain basic problems before these can be intelligently attacked, while others are of such a nature that they can be most effectively handled in industrial laboratories.

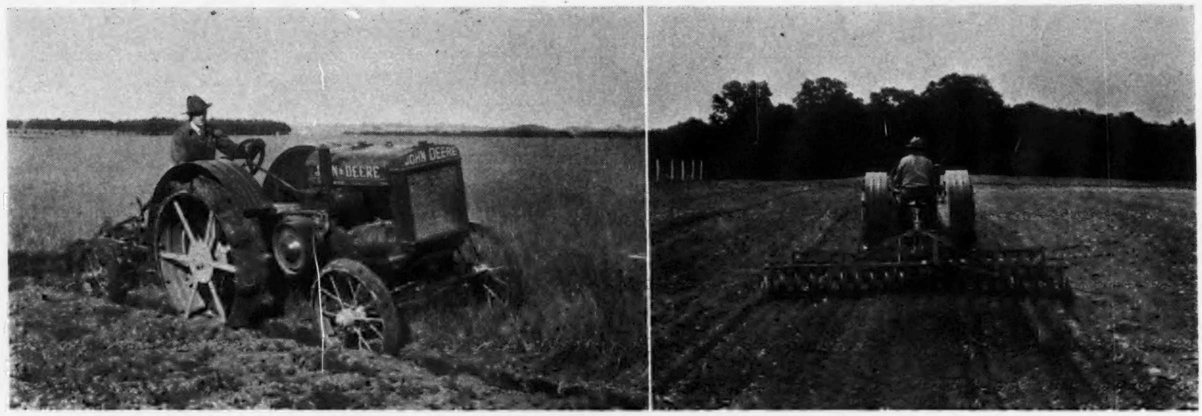
The advisory council, after a careful consideration of the Davidson report, decided to place special emphasis on a few of the more important equipment problems for 1927. The program which was adopted in March 1927 includes two general classes of problems—basic studies and application and economic studies. Under the former it was decided to center

*Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, November, 1927.

[1]Senior agricultural engineer, division of agricultural engineering, U. S. Department of Agriculture. Also director of the U.S.D.A. survey of research in mechanical equipment. Mem. A.S.A.E.

[2]Value of implements and machinery in 1920 was $3,594,772,928. (14th Census, U.S. 1920).

"We have passed the promotional stages of the development of farm equipment research. Our opportunities are before us in such volume as to tax the entire resources of the agricultural engineering profession. We have solicited this responsibility and it is now our duty to 'carry on' with the greatest industry. In doing this, we will not only broaden our professional activities, but we will be rendering a great service to agriculture. We must lend our efforts to promoting technical progress which is so essential to the welfare of the agricultural industry. In doing this, we may be making even greater contributions, for Glen Frank, president of the University of Wisconsin, says: 'The greatest social progress of the next fifty years is likely to come as a by-product of technical progress.' "



One of the primary functions of tillage machines is to improve soil tilth

efforts about the work in soil dynamics and tillage, and if possible to do some work along the line of weed control. The application studies involving both existing and new machines for crop production and processing must necessarily include certain economic phases as well as engineering investigations. In addition to crop production and processing equipment, pest control machinery, fertilizer equipment, and dairy and household equipment were included.

It is an inherent trait of the engineer to want to know the why of things. In any endeavor to apply our technical knowledge to agricultural methods or processes we immediately find ourselves inquiring about the why of the thing to be done, or the fundamental relationships existing between the materials handled or processed, and the various elements composing the machines utilized in accomplishing the operation. In our endeavor to apply engineering methods to agriculture we encounter a tremendous lack of basic data to explain why certain processes or practices are carried out. Much of our work now depends upon empirical methods, many of which are undoubtedly sound in principle but which cannot be definitely supported by factual material upon which technical analyses are made. For example, much of the labor and expense in producing a crop is included in tillage processes. Approximately 150 millions of dollars have been spent by American farmers during the months of July, August and September of this year in preparing the soil for the winter wheat crop, yet it is difficult to tell just what constitutes the proper field operations to produce the optimum seedbed preparation with the lowest cost. If the farm operators were questioned, they would state they plowed or cultivated their fields to get the proper tilth. Undoubtedly tillage methods are employed to improve soil tilth, but to tell how to secure proper tilth is a difficult matter. So far no definite measure can be applied to the soil which will give a tilth value.

This problem of tilth is of tremendous importance to agricultural engineers, for out of fourteen suggested problems in soil dynamics submitted in the Davidson report, eleven depend upon tilth values; eight of the twenty-six suggested problems in plows are dependent upon tilth, and forty-four of the ninety-six suggested problems relating to tillage machinery involve a better understanding of the basic principles of soil tilth. Engineers are probably more directly concerned with this term than the agronomists, since soil manipulation by machine methods is, among other things, apparently for the purpose of promoting tilth. Since such operations involve energy input, the engineer is interested in finding a measure of the thing he wishes to accomplish; otherwise it is difficult to attain the objective in the operation, or measure the efficiency of accomplishment. Perhaps investigations relating to tilth measurement do not fall directly within the scope of agricultural engineering research, but it must be admitted we are concerned with these problems and should offer our assistance in working out solutions. The experiment stations at Nebraska, Alabama, and North Dakota are interested in this general problem.

In addition to a more thorough knowledge of soil tilth, the engineer is concerned with the properties of soils as they affect the operation of equipment such as tillage machines. The properties of most interest to the engineer include cohesion, adhesion, friction, compaction, shear, soil liquids, etc. The relation of these factors to one another within the soil itself, as well as to the parts of the implements coming in contact with the soil, have a very definite bearing upon the design and operation of farm machines. In these matters the engineer is better qualified by direct training to conduct research than in problems involving tilth. Already a number of noteworthy projects are under way. The work of Nichols of Alabama is outstanding as a contribution in the field of soil dynamics. The state agricultural experiment stations in California, Nebraska, and Iowa are conducting studies closely related to this field but more in the direct line of machine applications, such as the efficiency of different types of tractor lugs under varying conditions of soil.

Every member of our Society has a direct responsibility in encouraging such basic studies. It is true that a relatively small number of agricultural engineers are fitted by training or temperament to go very far into such abstract investigations, but, after all, it is the solution of such problems which in the end contribute most to our progress.

Dean L. E. Call, of the Kansas Agricultural Experiment Station, in a paper presented several years ago at Ohio State University, entitled "Why Do We Plow?" gave, among others, the following conclusions on plowing:

> "Plowing and other methods of cultivation are beneficial chiefly because they are our most effective methods of killing weeds.
>
> "If weeds are killed, moisture will be conserved and plant food in available form will accumulate in the soil.
>
> "Since shallow plowing is usually as effective in killing weeds as deep plowing and much cheaper, it is doubtful if frequent deep plowing is justified.
>
> "Cultivate corn to kill weeds and for no other purpose.
>
> "A good rotation of crops controls weeds and thereby reduces the cost of plowing."

These quotations are not presented as Dean Call's' complete analysis on why we plow, but are given to impress agricultural engineers with the importance of weed control in farming operations. Farm tillage machines must be effective in controlling weeds if they function properly. If weeds do grow in crops, our harvesting equipment must be designed to avoid spread of the seed, if not the collection and separation of such seed from the harvested crop. Weeds are a menace to the efficient application of harvesting machinery for all farm crops, so it should be the objective of agricultural engineers to keep in mind that one of the primary functions of tillage machines is to control weeds. In the solution of these problems the engineer must work in cooperation with the botanist and agronomist. In all of our farm machinery investigations it would be well to devote more thought on how to control weeds. Most of the states could place more emphasis on this problem with profit.

The application and economic studies as approved by the advisory council are centered about the production problems

of two of our principal crops, corn and cotton. The greatest economic distress in agriculture following the war has been in the corn and cotton areas. It has been a case of abundant production in which the buyers fix the market price and the producers compete for the markets. Naturally such a condition creates competition, and those who through efficient methods produce crops at low cost are the first to enjoy profits. This situation has stimulated unprecedented interest in all types of farm machines which give promise of saving labor. At the same time it has created a critical buyer. The farm producer of today is in no frame of mind to take chances. He cannot afford to do it. Accordingly he is asking more questions about the management, operation, duty, and use of his farm machinery than ever before. He is looking to the state agricultural experiment stations for data to guide him in his production problems.

In the corn belt, generally, there is need of more data on the use of mechanical equipment in production. Considerable interest is evidenced in multiple-row planters and cultivators operated by mechanical power. Also, since the chief purpose of corn cultivation is to kill weeds, more experimental work is needed to determine if corn can be successfully grown without row cultivation. If this could be accomplished, special cultivating equipment could be eliminated, the rate of work increased, and possibly the equipment investment per acre decreased. These methods are worthy of careful study.

Progress in harvesting corn by mechanical methods is not keeping pace with other developments in corn production. Part of this has been due to the apparent effort of manufacturers to try to simulate hand labor in harvesting. In this effort the manufacturer has attained remarkable success, but the machine is too cumbersome, heavy, and slow in operation to meet with universal approval. The requirements of agriculture may be better met in a machine of less dead weight and lighter draft, and capable of more rapid harvesting. Instead of the present single-row picker, more attention might be centered on two-row snappers with stationary husking equipment located at the cribs. These comments are not intended as a criticism of the implement industry, but rather it indicates the necessity of studies conducted cooperatively between industry and our colleges. It takes time and much capital to develop such machines, and once developed it requires still more time to create interest among farmers. If developed cooperatively and with data available on actual performance, these difficulties are more quickly overcome.

Additional interest in methods of corn production has

Since shallow plowing is usually as effective in killing weeds as deep plowing and much cheaper, it is doubtful if frequent deep plowing is justified

developed from the invasion of the corn borer. This pest, which now threatens to infest the entire corn belt, is placing new and more stringent requirements in methods of tillage, harvesting and crop utilization. So far mechanical methods stand first as an effective means of corn borer control. Machines in themselves, however, are of little value in combatting this pest unless intelligently handled. While we know more regarding the control of the corn borer by machinery than ever before, we are constantly accumulating new problems. C. O. Reed and his associates in the engineering division of the government control forces at Toledo, after the first season of experience in regulatory work, have prepared a statement listing over 125 problems which need study and investigation. In this connection I should like to quote a portion of the report of the joint committee on the European corn borer, appointed by the American Association of Economic Entomologists, the American Society of Agronomists, and the American Society of Agricultural Engineers:

"That since the problem of successfully combatting the corn borer by mechanical processes depends upon a clear understanding and knowledge of the habits, life history and environmental influences affecting its spread into new territory, as well as upon the limitations of corn as to seasonal, varietal and cultural practices, more extensive studies of these factors should be made, particularly those which will assist the engineer in making specifications for improvements on present machines, as well as in the design of new and special machines for changing conditions.

"That in view of the interdependence of machinery requirements and design, research work should be undertaken cooperatively, and experimental and research programs should be correlated with federal control methods and large scale field procedure.

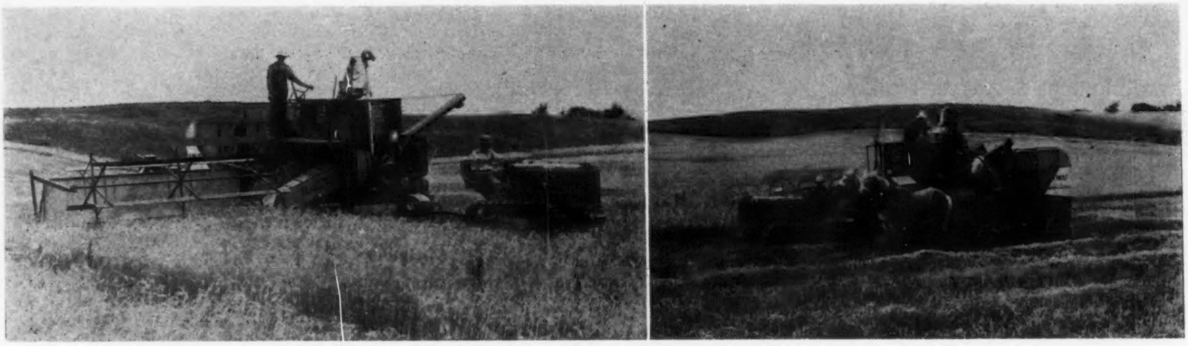
"The control of the corn borer by mechanical processes is of demonstrated importance and will undoubtedly continue to be so as long as the pest remains a menace to the corn crop of the country. Inasmuch as this method of control must continue until better methods can be found, we recommend that a comprehensive and vigorous research program relating to mechanical methods of crop production and commercial utilization be initiated by state and federal agencies.

"We recommend particularly investigations with machinery in corn borer control along cultural, harvesting and crop utilization lines. The use of rakes, burners and other stalk and remnant disposal machinery and devices to supplant hand labor, should receive more attention.

"That the experiments to determine the value of plowing under corn debris as a means of destroying the corn borer larvae should be extended. Such studies should include a determination of the comparative value of fall and spring plowing on different types of soil, of different dates and at different depths."

These recommendations which have considerable weight with state and federal authorities, afford all of the institutions in the corn belt an opportunity to carry on some phase of research in corn production including the utilization of feeds and by-products. Considerable work is already under way in Iowa, Wisconsin, Illinois, Indiana, Michigan and Ohio, and it is expected these states and others will correlate their efforts with the work of the federal government in working out the various problems of corn production under varying conditions. Our opportunities for such work are the best in the history of our Society.

The work in cotton production is equally important. The competition in cotton production, occasioned by the development of the Great Plains cotton areas through large-scale production, has created intense interest in all forms of machinery offering promise in decreasing cost of production. The Great Plains area is almost ideal for large-scale methods. The fields are large and fairly level, the soil is fertile, and the fall season is favorable for harvesting a good grade of cotton. The work on large-scale production conducted cooperatively by the Texas station and the U.S.D.A. is of particular interest in pointing out the possibilities of efficient mechanical equipment up to the time of harvest.



Combine investigations which were carried out on a comparatively large scale last year, have been even more widespread in 1927. Fourteen states, a majority of which are in the humid areas, have conducted field investigations

The progress made in ginning methods has been outstanding and this has brought new interest in mechanical methods of harvesting. The use of the cotton sled in West Texas in 1926 attracted nationwide attention. This year many different types of strippers, snappers, and pickers are being tried out with encouraging results. Throughout the cotton area harvesting has always been considered the control in production. Vast sums of money have been spent in developing machines and this year a few machines are in the field which are actually picking cotton. It looks now like mechanical cotton pickers are assured. It may take several years to develop these into perfect field machines, but undoubtedly the time is near at hand when the drudgery of hand picking will be eliminated.

The development of cotton strippers and snappers is encouraging. These machines will undoubtedly come into favor for cotton harvesting following frost periods. Their success is closely related to ginning processes and the spinning quality of the product. Here is a tremendous field for agricultural engineering development and it is gratifying to observe the keen interest exhibited, particularly in the southwestern states. The Texas station, cooperating with the U.S.D.A. Division of Agricultural Engineering, is now making special investigations of harvesting methods. Oklahoma is interested; Arkansas has a tentative project; Alabama, Mississippi, and South Carolina are working on special phases of production. In this field as well as in corn production, we have unprecedented opportunities to make worth-while contributions to agricultural progress, and the correlation of this work will insure earlier results.

Combine investigations which were carried out on a comparatively large scale last year, have been even more widespread in 1927. Fourteen states, a majority of which are in the humid areas, have conducted field investigations this year. These include New York, Pennsylvania, Virginia, Ohio, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Montana, and Idaho. When one considers that studies were made in Texas, Oklahoma, Kansas, Nebraska, and Wyoming last year, it would seem that this project is being well handled. A lot of the work now consists of adaptation studies of the use of the combine in areas and for crops for which it was not originally designed. The storage of grain, the utilization and disposition of straw and the adaptation of the machine for grain sorghum, sweet clover, flax, soybeans and other crops are all studies which come as by-products of the introduction of the combine in the winter wheat belt. Undoubtedly some of these studies will continue for several years. A close correlation of results is desirable.

Closely allied to the combine studies has been the work in grain and forage drying. Seven states, New York, Pennsylvania, Virginia, Illinois, Wisconsin, North Dakota, Kansas, and the U.S.D.A. Division of Agricultural Engineering are working on grain drying. Some valuable information is being uncovered, but there are yet much fundamental data to be developed. So far investigators seem to be agreed that artificial heat is essential to reduce the moisture content, but the best method and rate of reduction are still unknown. The recirculating method of passing heated air through the grain is gaining some preference.

Four states, Texas, Louisiana, Illinois, and Indiana are experimenting with forage driers. Oil-burning furnaces are being used to produce the heat. There is a widespread interest in hay drying, particularly in the South and east of the Mississippi River. So far the methods now employed have not passed the experimental stage.

Nineteen states are conducting studies relating to grain and forage grinding. Interest in this work has been due to the extensive investigations conducted with electricity in agriculture. For the most part, the studies have centered about power requirements and the possibilities of small grinders with automatic features. Much progress has resulted from these studies, particularly in the design and application of small hammer type mills to farm work. Through the cooperation of the various state workers, standards have been set up to measure fineness of grinding, moisture content, etc., so that mass data on these extensive investigations can be assembled. Progress in forage-grinding studies is still unsatisfactory, and it is doubtful if much can be expected until comprehensive feeding studies have been carried out to determine definitely the relative value of feeds prepared by different processing methods.

Studies with dairy and household equipment have been conducted in nineteen states. These studies have all been conducted in connection with C.R.E.A. work. Power and energy studies have predominated, although some splendid studies have been made of sterilizers, refrigerators, milking machines, and water systems. Development work with milk coolers has produced valuable results. In general, enough mass data have been assembled so that specific projects of a more technical nature can be conducted in laboratories under better controlled conditions. Some of the western and southern states are conducting studies with irrigation pumps.

The work with fertilizer equipment has been very limited. This problem will become more important each year in every section of the country. It is now generally recognized that the proper placing of the fertilizer has a lot to do with its efficiency in production. California and the U.S.D.A. have projects under way. More states should be interested.

Probably our next most important study of general interest is hay harvesting. Although hay is an important crop in practically every state, very little thought has been given to the analysis of hay production, particularly harvesting. This is a problem requiring studies as widespread as the combine. No organized work is now under way except artificial drying. This is an interesting field for development.

We have passed the promotional stages of development of farm equipment research. Our opportunities are before us in such volume as to tax the entire resources of our profession. We have solicited this responsibility and it is now our duty to "carry on" with the greatest industry. In doing this, we will not only broaden our professional activities, but we will be rendering a great service to agriculture. We must lend our efforts to promoting technical progress which is so necessary for the welfare of the agricultural industry. In doing this, we may be making even greater contributions, for Glen Frank, president of the University of Wisconsin, says: "The greatest social progress of the next fifty years is likely to come as a by-product of technical progress."

The Harvesting of Rice With Combines

By W. D. Smith[1]

WHEN rice is harvested in the usual manner by cutting it with binders, allowing it to cure in shocks for ten days or two weeks, and then threshing it, there is a liklihood of the grade and quality being materially lowered during the period between cutting and threshing, because of inclement weather. Rains frequently occur during the time rice is in the shock. If wet weather prevails for a long time or if threshing is done too soon after the rains stop, the threshed rice has a high moisture content and is often damaged. A large part of the expense of producing a crop of rice is the cost of harvesting under the present method.

On October 18 and 19, 1927, some rice was cut with combines near Lake Charles, La., to demonstrate that the combines can be used in rice fields. Two combines made by two well-known manufacturers were used.

This demonstration showed that combines can be used in rice fields under ordinary conditions for at no time was any great difficulty experienced in the operation of the machines during this demonstration. There were some bad spots in the field but by the proper manipulation of the tractors the operators were able to pull the combines through.

Definite and permanent conclusions cannot safely be drawn from one demonstration but the matter is so important to rice growers that it seems well to take stock of the tentative conclusions indicated by this test realizing fully that further tests may serve to modify some of these conclusions.

For the purpose of this demonstration a field of rice of forty acres was divided into two twenty-acre tracts. One tract was cut with the combines and the other tract was cut and harvested in the usual way. A study of the cost of harvesting by the two methods (insofar as it has been possible to ascertain costs), of the yields per acre, of the milling yields, and of the net return per acre has been made.

In Table I the cost of harvesting these twenty acres of rice with binders is shown, and in Table II is shown the cost of harvesting these twenty acres of rice with combines. It will be noted that in this case there is a large difference in cost in favor of the combines.

TABLE I. Cost of Harvesting Twenty Acres of Rice with Binder

Tractor and binder, 1½ days	
40 gal. gasoline at 14 cents	$ 5.60
1 gal. cylinder oil at 70 cents	.70
Tractor operator, 1½ days at $2.50 per day	3.75
Binder operator, 1½ days at $2.00 per day	3.00
Four shockers, 1½ days at $2.00 per day	12.00
70 lb. binder twine at 15 cents	10.50
Total cost of cutting and shocking	$ 35.55
Threshing 221 sacks at 40 cents	88.40
Total	$123.95

Yield: 221 sacks, or 44365 lb. (273.8 bbl.)

TABLE II. Cost of Harvesting Twenty Acres of Rice with Combine

Combine and tractor, 1½ days	
60 gal. gasoline at 14 cents	$ 8.40
1½ gal. cylinder oil at 70 cents	1.05
Tractor operator, 1 man, 1½ days at $2.50 per day	3.75
Combine operator, 1 man, 1½ days at $2.50 per day	3.75
Combine helpers, 3 men, 1½ days at $2.00 per day	9.00
Team and wagon picking up sacked rice, 1½ days	8.00
Total	$33.95

Yield: 272 sacks, or 55275 lb.

The moisture content of combine-cut rice is naturally high. In Table III it is shown that the average moisture content of the combine-cut rice was 19.2 per cent. The tract cut by the combines was opened up with a binder, and in dumping the bundles from the binder the operator allowed some of them to drop into a ditch which had water in it. These bundles were later threshed with one of the combines and this rice had a moisture content of 21.3 per cent. Inasmuch as this rice was put with the combine-cut rice the average moisture content of all rice from the twenty-acre tract cut with the combines was 19.4 per cent.

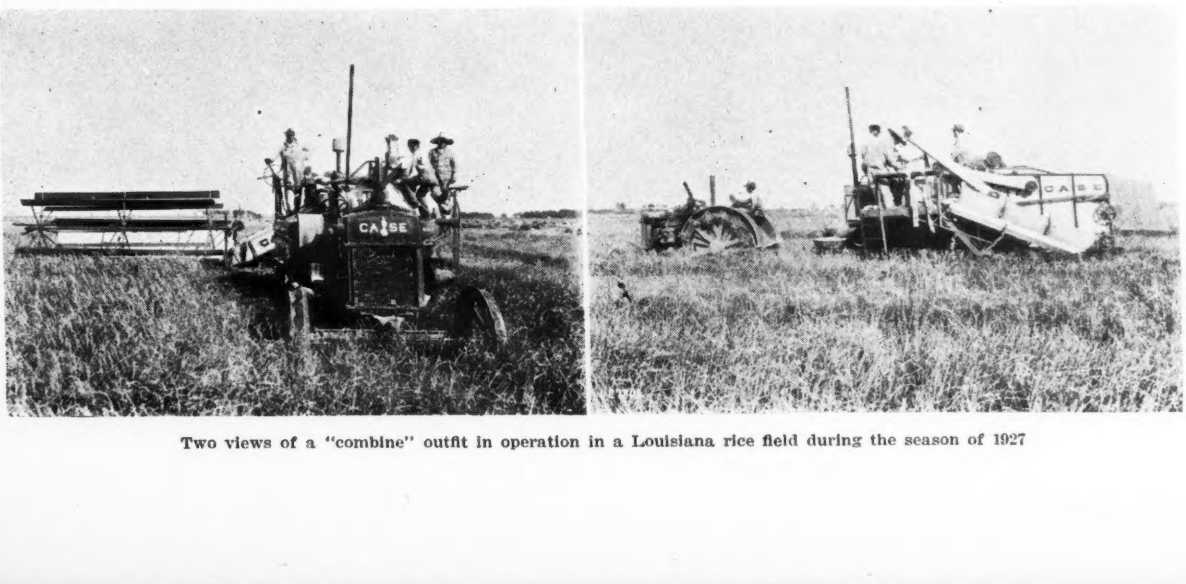
The weather during the period that the binder-cut rice was in the shock was ideal for the curing of rice and when this rice was threshed it was found to contain 12.6 per cent moisture.

At the time the rice was cut with the combines it was planned to transport the sacked rice to a mill in Lake Charles and dry it in a commercial drier and to mill it immediately. It was also planned to mill the binder-cut rice in this same mill as soon as it was threshed. In this way it was thought that results would be obtained which could be compared to advantage.

TABLE III. Moisture Content of Combine-Cut Rice and of Binder-Cut Rice

October 18, 1927—Sample taken on combine,	3:00 p.m.	19.0 per cent
—Sample taken on combine,	5:30 p.m.	18.6 per cent
October 19, 1927—Sample taken on combine,	10:00 a.m.	20.9 per cent
—Sample taken on combine,	2:00 p.m.	18.9 per cent
—Sample taken on combine,	3:30 p.m.	19.0 per cent
—Sample taken on combine,	5:30 p.m.	19.1 per cent
—Sample taken on combine,	6:00 p.m.	18.8 per cent
Average moisture content of combine-cut rice		19.2 per cent
October 19, 1927—Sample taken of binder-cut rice threshed with combine		21.3 per cent
Average Moisture content of all rice		19.4 per cent
November 23, 1927—Moisture content after drying of 64 bags of combine-cut rice		13.5 per cent
November 23, 1927—Moisture content after drying of 133 bags of combine-cut rice		13.8 per cent
November 29, 1927—Moisture content after drying of 75 bags of combine-cut rice		13.4 per cent
Average moisture content of all combine-cut rice after drying		13.6 per cent
Average moisture content of binder-cut rice		12.6 per cent

[1]In charge of rice investigations, Bureau of Agricultural Economics, U. S. Department of Agriculture.



Two views of a "combine" outfit in operation in a Louisiana rice field during the season of 1927

It was unfortunate that a series of unavoidable delays occurred which prevented the drying and milling of the rice until November 23. On that date it was found that the combine-cut rice, because of its high moisture content, was out of condition and in order that better results might be obtained the rice was graded into three lots, one of 64 bags, one of 133 bags, and one of 75 bags. Each of these lots was dried and milled alone. It will be noted in Table III that the combine-cut rice showed an average moisture content of 13.6 per cent after drying.

The combine-cut rice was weighed on the day it was received at the mill and its weight was 55,275 lb. There was no way of weighing the rice between drying and milling but by using the figures showing percentage of moisture before drying, weight before drying, and percentage of moisture after drying, with a special formula for the purpose, the computed weight of the combine-cut rice after drying was found to be 51,564.4 lb. This is shown in Table IV. Reducing 51,564.4 lb. to barrels it will be noted that 318.3 bbl. of rice were obtained from the twenty acres by the use of the combines. This is an average of 15.91 bbl. per acre.

TABLE IV. Weight of Combine-Cut Rice Before and After Drying and of Binder-Cut Rice

Weight of combine-cut rice on day of cutting	55,275.00 lb.
Computed weight of combine-cut rice after drying	51,564.40 lb.
Number of barrels of combine-cut rice from 20 acres after drying	318.30 bbl.
Yield per acre of combine-cut rice (after drying)	**15.91 bbl.**
Number of barrels of binder-cut rice from 20 acres	273.80 bbl.
Yield per acre of binder-cut rice	13.69 bbl.
Difference in yield per acre in favor of combine-cut rice	2.22 bbl.

The rice harvested and threshed in the usual manner was weighed on the day it was received at the mill and the weight was found to be 44,365 lb. This amounts to 273.8 bbl. for twenty acres or an average yield of 13.69 bbl. per acre. There is a difference in yield per acre of 2.22 bbl. in favor of the combine-cut rice. No doubt a part of this difference in yield per acre is due to the loss by shattering which occurs with rice cut with binders and shocked. The rice does not shatter greatly when cut with a binder but in the handling thereafter some loss is certain to occur.

In Table V the milling yields for the combine-cut rice are shown. As the artificial drying of the rice and the milling of the rice are regarded as separate operations the yield per barrel of the combine-cut rice is based on the weight of the rice after drying. In Table VI the milling yield for the binder-cut rice is shown. By comparing the figures in the two tables it will be noted that almost as good a yield per barrel was obtained for the combine-cut rice as for the binder-cut rice, notwithstanding the fact that the combine-cut rice had spoiled and was not in good condition at the time of drying and milling.

In Table VII a comparison is made of the value of the combine-cut rice and the value of the binder-cut rice. In order to arrive at comparative figures it has had to be assumed that the drying was done shortly after cutting the rice with the combines and that no spoilage occurred, as would probably be the case under ordinary circumstances. A deviation from actual facts has also been made in charging freight against the combine-cut rice as this rice was delivered to the mill with trucks belonging to the owners of the rice. The values per pound for the milled rice do not represent prices for which this rice was sold or what will necessarily be obtained for the rice when it is sold but are values which might ordinarily be expected in a normal season.

It will be noted that the indicated gross return for the combine-cut rice is materially larger than the gross return for the binder-cut rice because of the larger yield of rough rice per acre. The difference in monetary return is further enhanced in the net amounts because of the greater cost of harvesting by the usual method. The net value of the combine-cut rice is indicated as $970.35 and the net value of the binder-cut rice is $777.37. There is a difference in these figures of $192.98 in favor of the combine-cut rice for twenty acres. The difference in the indicated net value per acre is shown as $9.65 in favor of the combine harvested rice.

It is thought that the figures obtained from this demonstration warrant the careful consideration of this method of harvesting by all growers.

It seems that the principal problem involved in harvesting rice with combines is not in the cutting of the rice in the fields but in the drying of the rice after it is cut. It has been clearly demonstrated in experiments and in commercial practice that rough rice can be dried artificially so that it is in good shape for either storing or milling but there is not sufficient drying capacity in the rice belt to handle more than a small part of the crop with combines. It appears that the solution of the matter is the installation of driers on the large farms and at country points. Probably it will be more satisfactory to the large grower to have his own drier whereas the smaller grower may find it more economical to have his drying done at a central point.

It is highly desirable that the rice grower reduce his cost of production, if possible, in order that he may receive a greater net return per acre. The use of the combine in harvesting may offer the possibility of reducing the amount of money which must be expended in harvesting. This method of harvesting also tends to minimize the danger of damage in the shock by inclement weather.

TABLE V. Milling Yields for Combine-Cut Rice

Lot of 64 bags			
Head	6900 lb.	Screenings	1000 lb.
Second head	400 lb.	Brewers	340 lb.
Lot of 75 bags			
Head	7800 lb.	Screenings	1200 lb.
Second head	1000 lb.	Brewers	340 lb.
Lot of 133 bags			
Head	13600 lb.	Screenings	2100 lb.
Second head	1300 lb.	Brewers	580 lb.

Total yield of head rice for combine-cut rice	28300 lb.
Total yield of second head for combine-cut rice	2700 lb.
Total yield of screenings for combine-cut rice	4300 lb.
Total yield of brewers for combine-cut rice	1260 lb.

Yield per barrel of combine-cut rice:

Head	88.90 lb.
Second head	8.48 lb.
Screenings	13.50 lb.
Brewers	3.96 lb.
Total	114.84 lb.

TABLE VI. Milling Yield for Binder-Cut Rice

Head	25100 lb.	Screenings	3400 lb.
Second head	2400 lb.	Brewers	680 lb.

Yield per barrel of binder-cut rice:

Head	91.60 lb.
Second head	8.76 lb.
Screenings	12.40 lb.
Brewers	2.48 lb.
Total	115.24 lb.

TABLE VII. Comparison of Values of Combine-Cut Rice and of Binder-Cut Rice

Combine-Cut Rice		
Head—28,300 lb. at 4c per lb.		$1132.00
Second head—2700 lb. at 2½c per lb.		67.50
Screenings—4300 lb. at 2c per lb.		86.00
Brewers—1260 lb. at 1½c per lb.		18.90
		$1304.40
Less—		
Cost of harvesting (Table II)	$ 33.95	
Freight—55,275 lb. at 8c per cwt.	44.22	
Drying and milling—75c per barrel basis weight before drying 341.2 bbl. at 75c per bbl.	255.88	334.05
Net value of combine-cut rice		$ 970.35
Binder-Cut Rice		
Head—25,100 lb. at 4c per lb.		$1004.00
Second head—2400 lb. at 2½c per lb.		60.00
Screenings—3400 lb. at 2c per lb.		68.00
Brewers—680 lb. at 1½c per lb.		10.20
		$1142.20
Less—		
Cost of harvesting (Table I)	$123.95	
Freight—44,365 lb. at 8c per cwt.	35.49	
Milling—273.8 bbl. at 75c	205.39	364.83
Net value of binder-cut rice		$ 777.37
Net value of combine-cut rice		$ 970.35
Net value of binder-cut rice		777.37
Difference in net value of 20 acres in favor of combine-cut rice		$ 192.98
Difference in net value per acre in favor of combine-cut rice		$ 9.65

Electrical Refrigeration of Milk*

By E. E. Alderman[1]

HEALTH authorities are realizing that the proper care of milk must start on the dairy farm where it is produced. Pasteurization in the city milk plant cannot make good milk out of bad. The milk must be of the highest quality to begin with if the final product is to be all that is desired.

Mechanical refrigeration has long been used in large milk plants for cooling and storage. It was discovered it was much more economical and efficient to apply the refrigeration directly to the work to be done than to manufacture ice and then use the ice in the cooling process. Even where natural ice was available it was found that mechanical refrigeration was more satisfactory, as the direct cooling made lower temperatures possible and permitted a closer regulation of the refrigeration in relation to the cooling needs.

For the speedy cooling of large quantities of milk the aerator has been found to be the best. The milk to be cooled is poured over the outside surface of the aerator and is cooled by contact with the brine-chilled surface of the aerator. The chilling is accomplished by circulation of brine through the interior passageways of the aerator. Some aerators are provided with connections so that cool well water, if available, can be circulated through the upper half and brine used only through the lower half.

The problem of milk cooling by use of the aerator may be summed up to that of supplying a large quantity of refrigeration in a very short time. To supply a large quantity of refrigeration without some special arrangement would require an extraordinary large investment, out of proportion to the results obtained. The same results, however, can be obtained by storing up the refrigeration between milkings and making it available in the short time that is allowed for the milk cooling. This is accomplished by the use of a large brine tank supply where the refrigeration is stored through several hours of running time of the compressor and can be delivered to the aerator when needed by means of a circulating pump.

As previously stated, the aerator is most satisfactory where large quantities of milk are to be cooled quickly. The cost, however, for the small dairyman is a limiting factor as he must purchase equipment consisting of a large aerator, brine tank properly insulated, brine circulating pump, a large cooler for the storage of the milk after it has been cooled, a compressor of sufficient capacity, and spend his time in operating the aerator while the milk is being cooled.

Such equipment when completely installed (including labor) generally runs in cost from $1,000 upwards. One company manufacturing electrical refrigerators has placed on the market a unit aerator and storage cooler, including compressor, for use on the small dairy farm for a cost of about $800. This meets the needs of many dairymen, but there is still a large number that require a cheaper milk cooling installation.

To bring electrical refrigeration of milk at an economical cost to the small dairymen producing from 10 to 50 gal. at each milking, the submerged tank-type milk cooler has been developed. This cooler can be installed at about half the cost of the aerator equipment for the same capacities, and permits the collection of better grades of milk from the farms, produced and cooled under conditions to satisfy the regulation of the state and city health authorities.

Insulation is absolutely necessary. Many of the first milk coolers were constructed of concrete with no insulation at all. Where insulation was used, no attempt was made to keep it dry and at its most efficient point. As a result heat leaked through the walls of the cooler. In the present day tank-type coolers, three or four inches of corkboard or similar insulation is used and the heat leak into the cooler from the outside is reduced to a minimum. This insulation is treated to make it waterproof and it is thus maintained at its highest efficiency at all times.

Test installations have shown that between four and five gallons of water should be used in the cooler for each gallon of milk that is to be cooled after each milking. This amount of water combined with a cooler of proper design and the right method of use, will make it possible to cool milk to below 50 deg. within about two or three hours.

A submerged tank-type cooler for test was constructed on a farm near Dayton, Ohio, early this summer (1927). It represents the total of all information that has been gathered from all dairy states.

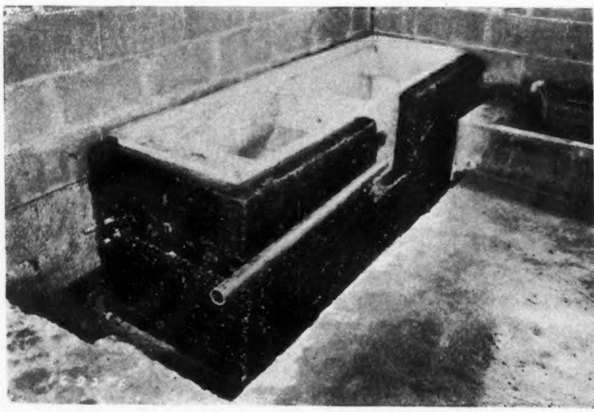
This cooler is designed to cool 20 gal. of milk morning and evening, making a total capacity of 40 gal. of milk a day. The cost of the cooler, the electrical refrigerating equipment, and all labor involved in construction and installation was about $400.

If the farmer or dairy owner can supply the labor involved, the cost of the cooler can be decreased by $50 to $75, bringing the total cost well within the means of thousands of small producers of milk.

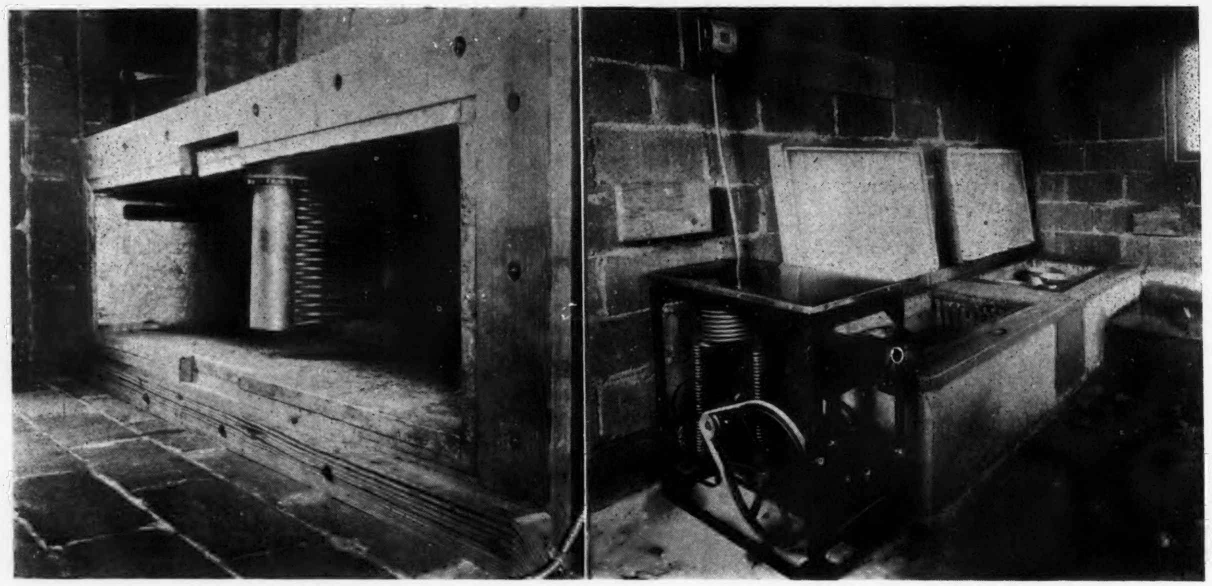
The metal tank was insulated with 3 in. of corkboard made waterproof with a special asphalt paint. A reinforced

*Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Pittsburgh, Pa., October, 1927.

[1]Frigidaire Corp., Dayton, Ohio.



(Left) Corkboard insulation in place on the cooling tank and covered with asphaltum paint for protection against moisture. (Right) Tank and insulation encased in concrete



(Left) This view shows the coil for cooling the water installed. Trim boards are used around the coil to prevent injury to it from the milk cans. (Right) Complete installation for electrical refrigeration of milk.

concrete base and walls 4½ in. thick were cast around and outside the cork to provide the necessary strength. Wood was used along the top edge of the structure to protect the cork and concrete from wearing during use and for an anchorage to fasten the hinged lid. The lid was insulated with 2-in. corkboard, faced with boards and sheet metal. It was counterbalanced to facilitate use. Refrigeration is provided by the compressor and coil, the latter being submerged in the water in the tank.

Operation of the compressor lowers the temperature of the coil and in turn lowers the temperature of the water. When the milk cans are placed in the water of the cooler, the refrigeration process begins at once. It is advisable to agitate the milk in each can every 15 min. for the first hour in order that the cold milk along the surface of the cans will be mixed completely with the warmer milk in the center of the can. The low temperature in the cooler makes it possible for the milk to be held until delivered without deterioration in quality.

This type of cooler is easily constructed. The refrigerating equipment can be furnished by dealers in all parts of the country, and the material necessary for building the tank can be obtained easily and constructed by the dairyman. Concrete work can be done on the farm and high-priced labor eliminated.

The size of the tank type cooler can be regulated to meet the needs of the individual dairy. While there is no necessity of providing excess capacity, future needs must be taken into consideration as this type of milk cooler cannot be enlarged easily.

Operation costs with electrical refrigeration are low, varying with the cost of current, and the saving over the use of ice will depend upon the cost of ice. Where it is necessary to haul ice from distant points the savings will be increased.

One of the most important factors in favor of electrical refrigeration for milk cooling lies in the automatic operation of the compressor. After the compressor controls have been set to provide the desired temperatures, the compressor will operate without further attention. The operating time of the compressor will vary, depending on the amount of milk to be cooled and the weather conditions.

Development of the direct expansion coil has made unnecessary brine tanks or pipes within the tank-type cooler. This conserves space and makes possible more efficient operation.

Tank-type coolers are recommended for use when between 20 and 50 gal. of milk are to be cooled at each milking.

Effects of Machinery on Labor

IT IS agreed that as productivity is the basis of wages and the general welfare, there should be ready cooperation in all policies which clearly tend to increase it and this should make an end of opposition to labor-saving methods and machinery. It is not unnatural that wage earners should view with antagonism the installation of machinery which seems to displace labor, but the wisest labor leaders know that in the aggregate the effects of machinery are not to reduce employment but to increase and cheapen production.

So long as the people have wants unsatisfied there will be room for more machinery, for wherever it releases labor from present uses it will release new purchasing power sufficient to employ it. There may be a shift of labor, as from carriages to automobiles, but no less employment.

Since the effect of machinery is not to reduce employment but to increase real wages, the idea that working hours should be reduced to offset the effects of machinery is an obvious fallacy. Instead of offsetting a loss, that policy would offset a gain. Instead of preventing the workingman's degradation it would prevent his advancement. If it could be carried out it would put an end to industrial improvement and the rise of the standard of living. The answer to the workingman's fear of machinery is to be found in a comparison between the labor conditions in China and those in the United States.

There is a fair balance to be struck between rest, recreation and leisure on the one hand, and labor, production and possessions on the other, but it must be borne in mind that it is impossible to divide any more than is produced, and that a rising standard of living is possible only with constantly increasing production.—George E. Roberts, vice-president, National City Bank, New York.

A Business View of Farm Drainage*

By Q. C. Ayres[1]

IN THIS enlightened age it would seem that the benefits of drainage both direct and indirect are so well known and the potential profits from this kind of investment so generally established that every individual would hasten to grasp the opportunity and drain his land without delay. Why is it then that 39,110,357 acres of farm land[2] are declared by owners to be too wet to cultivate and countless other acres would probably yield handsome returns from drainage?

To my mind five deterring factors suggest themselves:

1. The discouraging example of poorly planned and improperly constructed projects
2. Lack of appreciation and unwillingness to pay for engineering service and advice
3. Unsound economic beliefs which foster expenditure of limited funds on less worthy enterprises
4. Inherent difficulty of organizing farmers for concerted action in any cause
5. Lack of legal machinery to so organize and the difficulty and cost of securing financial assistance

The first four of these obstacles can and will be overcome by individual effort on the part of agricultural engineers. The fifth would seem to call for some form of systematic cooperation. It is my purpose, therefore, to direct attention to some of the elements involved in the latter proposition and to stimulate thought and discussion along these lines.

In the first place, the question arises as to what degree the farmer with ample resources can truly afford to drain. If we eliminate lands deficient in fertility and isolated wet spots that require only a single line of tile, the problem resolves itself into two subsidiary parts:

1. Under stable conditions how closely should soil water be permitted to approach the ground surface for various crops?
2. What depth and spacing of laterals are necessary for different soils to hold the water table at the optimum level?

The answer to these questions can never be wholly satisfying until our fund of research data advances far beyond its present limits, without prejudice to the excellent work being done in Minnesota and in Iowa and by the U. S. Department of Agriculture in North Carolina and elsewhere. Until all the facts bearing on this situation have been discovered and applied, the farmer should never expect to realize from his drainage investment the most bushels per dollar nor can he with the greatest effectiveness "turn water into wealth."

Granting that the problem has been satisfactorily solved, how then shall we measure the amount a given farmer should economically expend for drainage at a given time? Certainly a reasonable relation should exist between his expenditures for drainage and for other purposes. This relation would vary for each individual farmer and would need to be determined by making an analysis of each man's financial and investment status, remembering that, in drainage, the ratio of benefits to expenditure is not constant.

Two cases should be considered: One in which the farmer is free to discharge his tile without expense into a natural outlet, and the other in which the owner is taxed for the privilege of connecting with an artificially constructed drain. In the first instance, no tangible penalty is incurred by delay, but in the second the owner is put to a considerable expense for drainage with no compensating benefit unless he spends more money to take advantage of his outlet privilege. This latter is an intolerable situation that should not be allowed to exist for any considerable length of time though the fact that it does exist in many cases due to insufficient financial resources cannot be denied.

The general relation between expenditures and benefits would be as shown in the accompanying graph.

Curve No. 1, representing conditions within organized outlet districts, would not begin at the origin since some investment is necessary before any benefit is received. Relatively heavy expense for tile mains would cause the curves to rise sharply at first and not flatten out until the effect of field laterals begins to be felt. When the point "A" is reached any further expenditure would not result in a correspondingly great benefit, so that this point represents an investment limit beyond which it is not profitable to go. By operation of the economic law of deminishing returns, the maximum yield per dollar occurs at point "A."

In all probability the present status of most farm drainage systems would appear on the curve somewhere between the points "O" and "B," not excepting those that are believed to provide thorough and complete drainage. This situation is not likely to improve until scientific knowledge becomes more exact and facilities for supplying money more adequate.

For some time to come the practicability of extending farm drainage much beyond the point "B" would seem to be questionable. There are other investments that have a just claim on a part of the farmers capital though, if the land is wet enough, drainage is a prerequisite for any other expenditure. In economic language the point "B" might be said to represent a condition where the law of optional demand takes effect.

Curve No. 2 is similar in every respect to Curve No. 1 except in initial expense for outlet purposes. This difference remains constant throughout.

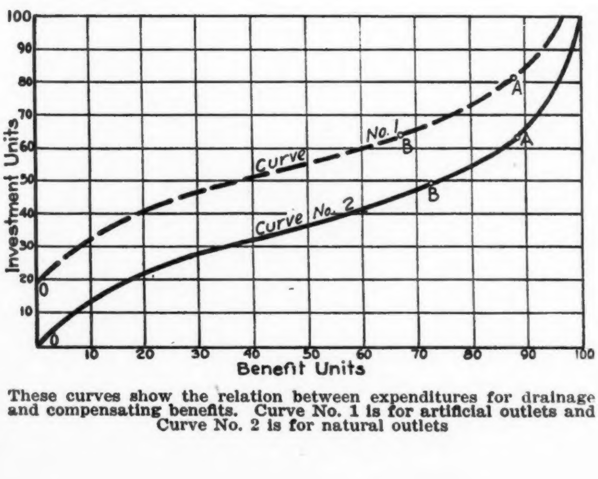
In order to enjoy the results of drainage at the present time, the average farmer either must have saved a sufficient sum from his operating porfits or else he must borrow from local banks on short time loans at high rates. If his land is already heavily encumbered, it would be difficult to borrow for any purpose. Hence, the man who is in most urgent need of drainage profits is denied the opportunity to secure them.

The writer can see no adequate reason why the advantages of group credit and long-time financing accorded by our drainage district laws should stop short of complete lateral drainage, if the landowner so desires. Only in this way can all owners, in practice as well as theory, pay their share of the cost of the work out of a part of their marginal proceeds. The chief objection to this procedure is purely academic if not ephemeral in character. There are those who profess that the state should assist the individual only in matters involving property rights of others, over which he has no legal control. It is not a proper function, they hold, for the

*One section of the report of the Committee on Drainage presented at the 21st annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, Calif., June, 1926.

[1]Associate professor of agricultural engineering, Iowa State College. Mem. A.S.A.E.

[2]1920 Census.



These curves show the relation between expenditures for drainage and compensating benefits. Curve No. 1 is for artificial outlets and Curve No. 2 is for natural outlets

state to assist or to have any voice in the management of private lands after outlet facilities have been provided.

It is hard for me to see why insolvency, so far as being able to finance lateral drainage is concerned, is much less of an obstacle for owners to overcome than legal barriers would be, without the opportunity for organization. Certainly, unless some kind of help is provided, the actual effect on the wet land would be negative in both cases. At least one precedent has been provided for land within organized drainage districts by an act of the legislature of the state of Mississippi passed in 1922, (Chapter 212, Acts of 1922), which authorizes the formation of tile lateral districts with adequate provisions for making the act effective. Under this law, any of the landowners within an organized outlet district may together petition for a tile lateral district. "Their lands, or parcels of land, need not be contiguous or adjacent. Each may put in all, or any selected portion or portions, of his land. Any in all, or any selected portion or portions, of his land. Any part or parts of such land covered in the petition may be rejected for tile drainage, as investigation may disclose its impracticability."[3] Such districts are permitted to issue long-term bonds and to enjoy other advantages that accrue from collective credit facilities.

[3]W. L. Thompson, consulting engineer, Greenville, Miss.

Another source of effective aid might come through the establishment of a system of federal land banks, or through the expansion of those already in existence. These banks would deal directly with the individual farmer and would enable him to borrow adequate sums at low interest rates for the purpose of constructing lateral drains.

Still another possibility would be to make loans directly from government funds with provision for repayment of principal and interest over long time intervals. Quoting Prof. L. G. Heimpel of MacDonald College, Quebeck, Canada, "Many farmers we find are unable to finance drainage work. This problem has been met by the tile drainage act of Ontario which provides a 20-year loan up to $2000 per 100 acres at 5 per cent interest. Last year (1925) the government advanced $257,900 for this work."

In conclusion, I repeat my conviction that the situation is grave enough to warrant some kind of vigorous action looking toward the relief of farmers struggling to drain their lands under a great financial handicap. I can think of no kind of loan that would contribute more directly to farm relief or that would accomplish more in the way of reducing production costs than this. To paraphrase an old familiar quotation, "What shall it profit a man to gain a whole world of outlets and lose the chance to cash in on his privilege?"

Twelve Steps In Using a Community Septic Tank Form

IN THE last decade improved farm sanitation by means of the septic tank has added another feature to the ever-growing comfort of living in the country, for, when properly installed, the septic tank has proven to be a highly sanitary and almost indispensable convenience. But little effort is now needed to convince the farmer that he should dispose of all sewage by the septic tank method in order to insure the health and safety of his family and to make his home more pleasant to live in.

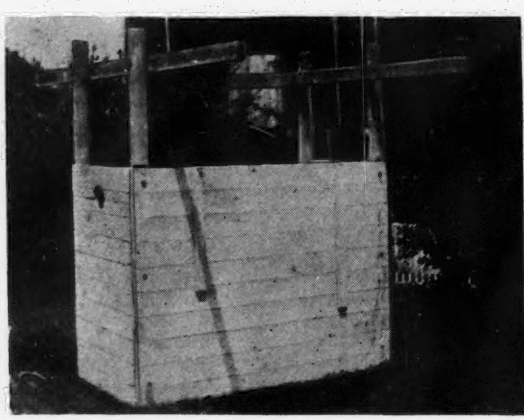
The greatest hindrance to the rapid development of this sanitation movement is the cost of installing this type of sewerage, one of the major items of this cost being that of the forms needed in the construction of the concrete tank. To meet this situation, the agricultural engineers of some of the state college extension divisions have developed the idea of community septic tank forms, articles on which have formerly appeared in this journal. By this means a number of tanks are built from the same standard form, thus reducing the cost of installation as well as insuring a proper method of construction. Here, again, another problem has arisen, that of preserving the form so that a large number of tanks may be built from it. To solve this last problem and to form a set of instructions covering the standard septic tank installation, John R. Haswell, extension agricultural engineer of Pennsylvania State College, has issued the following rules governing successive steps in the use of the form and the construction of the tank. These directions have been written for the improved kind of septic tank form developed since the Pennsylvania Agricultural Extension Circular No. 89 was published, but much of the information in the circular is of value when used together with these rules:

1. Obtain a standard wooden septic form, 3 feet wide, 6 feet long, and 4½ feet high. If the county agent has none available, construction details for the form may be found in Circular No. 89, mentioned above, and its supplement. The corner posts of the form should be bolted and not nailed to the boards so that removal without breaking up the form may be had.

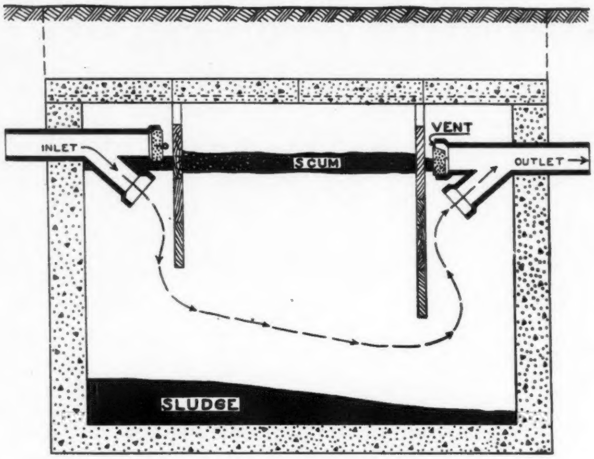
2. Other materials needed are: Two 4-inch glazed terra cotta bell sewer pipe to connect the house outlet to the tank inlet; okum and cement for sealing pipe joints on the house-tank line; 16 sacks of cement; 1½ cubic yards of sand, and 3 cubic yards of clean gravel or stone.

3. Plug the straight part of the two Y branches by placing a disk of tin or tar paper within the bell and filling the bell with a fine mixture of concrete. Make a small opening through the concrete, in the pipe to be used for the outlet, along the side opposite the Y branch. (See accompanying illustration.) Allow the Y branches to stand a day.

4. Mark off the dimensions of the excavation, making it four feet one inch wide and seven foot long, by using cords or a frame guide. Drive four posts so that they will support the cross arms of the frame when in place, or blocking may be used.



(Left) The original community septic tank form of bolted construction. Fifty Pennsylvania counties now have these forms. (Right) A typical septic tank with form removed and wooden baffles in place



A cross-sectional view showing how the septic tank works

5. Make the grade of the sewer line from the house to the tank so that a fall of approximately 4 feet in each 100 feet is obtained, or as near this as possible.

6. Be sure the markings for the excavation are square and true, then dig the hole to a depth that will bring the line from the house in at the proper level, allowing 5 inches below the frame depth for the concrete bottom. Short ditches, to accommodate the Y branches, should be dug on the center line of the tank.

7. Bolt the form together with the heads of the bolts on the inside of the box. This assembling should be done on level ground. Check the distance from the cross arms to the bottom of the inlet opening to see that the "Inlet Drop" is correct. Grease the corners of the frame thoroughly and oil the sides with a one-to-one mixture of kerosene and linseed oil.

8. Put the form into position and plumb the sides, changing the supporting stakes or blocking as needed. Place the Ys so that the pipe with the solid plug is at the inlet and the one with the vent at the outlet.

9. Concreting should not be started unless all of it can be placed without interruption. First pour very stiff concrete around in the bottom of the wall space and tamp well. Wetter mixes may be used after the first eight inches of wall is in place. As soon as the sides are filled, proceed with the next step.

10. Lay a 5-inch bottom of almost dry concrete and tamp until water shows on the surface. Be careful to keep the concrete from filling above the lower edge of the form as this often causes destruction of the lower boards in removal. Make three or four reinforced cover slabs as a top for the tank. Allow these to set several weeks. Slate or flag stones may be used. Wood is not recommended because of rapid deterioration.

11. When the concrete has firmly set, remove the form with care and place the baffle boards. Fill the tank with water for testing and for curing the concrete. Connect the inlet Y to the house sewer by sealing the flat joint with a cement mortar collar. Connect the outlet Y to at least 100 feet of open-joint absorption tile, the lower end of which should be sealed. The absorption line should have a fall of two inches in every 100 feet. (For details refer to pages 12 and 14 of Circular No. 89.)

12. Place the cover slabs and grade earth over the tank to a depth of about one foot. Inspect the tank at least every five years and pump out the sludge so that it does not get over a foot deep. Also skim off about six inches of the scum. Use no chemicals.

The Pennsylvania agricultural extension service has built about eight hundred septic tanks of this design, and in no instance where the foregoing twelve steps were followed has the system been known to fail.

A Thought on Research

A RESEARCH engineer must eat. Eating requires a pay envelope, the pay envelope necessitates a job and the job requires someone who believes in the value of research. It may be that these facts are just beginning to be recognized in the automotive field, as it is only recently that any serious effort seems to have been made to "sell" research to the industry. Unfortunately the sales campaigns have left some rather erroneous impressions on the minds of those whom it was desired to reach.

For example, not a little has been said of pure and applied research and the implication has been that something of a loss in caste was likely to attend the pursuit of applied rather than the so-called pure research. Frequently, too, the value of pure research has been illustrated by citing accidental discoveries that have led to untold wealth in fields unthought of at the time the research was initiated. All this may make a fascinating story but it leaves the impression that research, particularly the "pure" type, is a rather aimless procedure; whereas the purer the research the more definite usually is the aim.

Applied research creates a fly-swatter to crush the fly that loiters on your bald dome. Pure research furnishes screens to keep out the fly, or better yet, it alters conditions until the creature has no incentive to linger in the vicinity. The distinction between pure and applied research is therefore primarily one of time. Applied research cures a trouble after it has arisen, pure research cures the trouble before it arises.

To pay a bill before it becomes due requires available lands. To cure a trouble before it arises requires available knowledge. It is the function of research to provide that knowledge. A research department therefore is a bank of knowledge in which is available on demand knowledge in a form to be readily applied to the purpose at hand.

The ancients used a hiding place rather than a bank for the storage of their valuables, and too often now the hide-and-hunt system is employed in the storage of research information.

If research is the curing of a trouble before it arises it might appear that the efficacy of research should be judged solely by the absence of trouble. Such is by no means the case, for the absence of trouble may indicate merely the absence of progress. The goal of research is not so much "make no mistakes" as rapid progress with few mistakes. Research should not be a matter of applying brakes to get slower motion but rather of cleaning the windshield to permit faster motion with safety.

Research has justified itself only when an organization feels secure in plunging forward with that cheerful audacity that makes the game worth while.—S. W. Sparrow, research engineer, The Studebaker Corp., in the February, 1928, issue of "S.A.E. Journal."

Reducing Cost of Growing Corn

TWO-ROW cultivators, plows, harrows, disks and listers scored a clean cut victory from a standpoint of man labor economy and reduction of corn production costs in a survey conducted during 1927 in Iowa.

Six-horse teams on two-bottom 14-in. gang plows required the smallest amount of man labor among the horse-drawn plows, while the amount of horse labor per acre on this same outfit was slightly greater than when a five-horse team was used. The cost for man and horse labor with the six-horse team was slightly less than when five horses were used. However, the man labor for tractor plowing was much smaller than when horses were used.

Combining Utility and Beauty in Farm Homes*

By W. A. Foster[1]

THE American farm home has reached its greatest development during the last score of years. Its rise has been gradual from the log cabin of the clearing or the sod shelter of the prairie. It not only must be a fit place to live in but an efficient place to work in.

Abundance of light, air and running water, with all conveniences, sound economical construction and a convenient arrangement for comfort, contribute towards making farm life attractive and wholesome. A house which fails in providing these essentials is wasteful. Energy is lost in the care, fuel is wasted in the heating, and health is often impaired by living in it.

Convenience, economical construction and sanitation have overshadowed appearance in farm house design. The plan was made efficient. Appearance was forgotten or was incidental because the one responsible for the plan or design had, as a general rule, no artistic training. As a result, the ugliness of many farm houses could have been turned into beauty if the plans had been properly handled.

Two of the three general principles on which the art of architecture is founded—fitness and strength—have been employed in farm home planning and design. The third principle—beauty—has been neglected or forgotten. Without fitness the farm house is useless and soon falls into decay or is made over; without strength it falls, but without beauty it is merely a collection of materials. It cannot be called architecture, even though it may last for years as a reminder of its ugliness and the poor taste of its builder. Since architecture rests upon these three principles we must understand how they apply to architecture so we may appreciate beauty in the farm house.

The first principle of architecture—fitness—deals with the practical uses of buildings, their arrangement and convenience. The church, for example, represents the community in a dignity and inspiration which is a visible symbol of reverence and piety. Fitness also meets the requirements of heat, light, ventilation, communication and sanitation, as well as its adaptation to the special purpose for which it has been erected.

In addition, fitness is concerned with climate and location. In the snowless South, the steep roof is out of place just as much as the flat-roofed, Spanish type is unfitted to our snowbound plains.

Under the second principle of architecture—strength—come the practical methods of construction in making the building strong and durable. The vertical supports, beams and trusses, arches and vaults—timber, steel and masonry—are the product of the ages in constructive achievement.

The third general principle in architecture—beauty— is as essential to the farm house as fitness and strength. Beauty is found in materials, such as color or texture; in form and mass or in the expression of the structure as produced in character, association or material.

The three divisions of a building according to Fiske Kimball are the walls, the roof and the openings. The mass and shape of a house is determined by the walls and roof and the effect is produced by the openings, their shape, proportion and grouping and the added ornament or decoration.

The log cabin of our forefathers had many of the elements of good architecture. It was fit, it was suited to its surroundings, and it was convenient for practical use. It met the needs of its occupants in construction and arrangement. It was well lighted and it was well ventilated by the massive fireplace and chimney. It was strong and sturdy to resist wind, storm and attack by Indians. It was warm, since cold could scarcely penetrate through the logs or the chinked clay. It was beautiful. Its color soon harmonized with the landscape—the clearing. Its exterior was simple and sensible. It expressed itself and occupants. Every home should do that.

The farm house has become an individual problem. The number in the household and their habits; the type of farming engaged in, whether livestock, fruit, grain or dairy; the terrain; the climate and the community life—social and economic—are contributing factors in farm house design. With these many demands, the farm house planning has failed, in many cases, to meet all requirements and at the same time be beautiful. Individuality has been lost in stock plans. "An eight-room house for a large family for a quarter, an eighty and a forty." A square box-shaped exterior with uninteresting hip roof is prescribed and urged upon the prospective builder, without any regard to setting. Then the carpenter supplies the detail, usually his own personality. It is a simple matter to drive through a community and pick out houses built by contractor Bill Smith or barns built by carpenter Sam Jones. Smith's personality crops out in dormers, entrances and cornices. Jones' barn cupolas are pigeon cotes or sparrow harbors.

The owner secured the plans from the agricultural colleges, material dealers or the family newspaper. They were made general by the engineer or amateur who sought an efficient arrangement, an economical construction, with provisions for all utilities and communication. He had not time to study mass, roof lines or detail, because quantity rather than quality was demanded. Then again he had not been trained artistically. His work was entirely mechanical without those niceties which would add beauty to plan or exterior. He has pioneered and attempted to meet the need. Considerable credit is due him for these efforts.

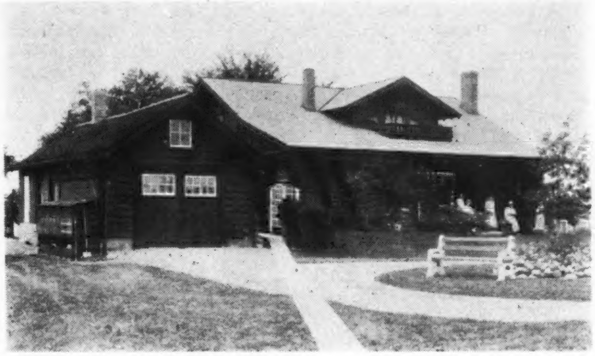
Farm folks have awakened to the call for attractive things about the farm and particularly in the house. Good lines are sought in the family car. Attractive colors in farm machinery have made a strong appeal. Straight rows in the grain fields, well-kept fences and clean fence rows

*Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December, 1927.

[1]Assistant professor of rural architecture, University of Illinois. Mem. A.S.A.E.

The ugliness of many farm houses is the result of beauty having been neglected or forgotten. It is possible to combine beauty and utility—and this calls for the three-fold efforts of the agricultural engineer, the home economist and the architect.

"The best planned and most attractive farm homes are the product of many factors. First, there must be sufficient interest on the part of the owner so that he will want and attempt to secure the best. Then, he must have the fullest cooperation of the agricultural enginer, the architect, and the contractor or builder."



are in style. Color, form and action are demanded in purchasing breeding stock. Even in the feed lot, the feeder wants animals uniform in size and color. Individual pride has broken out and become contagious. Even in the house Mrs. Farmer wants attractive furnishings. Curtaining, tapestry, and rugs are selected for harmonizing colors, texture and durability. Mary's lamb, the St. Bernard dog or the basket of roses motifs are no longer found. Simple furniture of good design has found a ready market from the farm folks. Manufacturers have met the demand. Even the typewriter companies have recently realized that a duco-finished machine makes a flapper typist more efficient.

Eleven and one-half billion dollars are invested in farm buildings, according to the 1920 census. This is equivalent to the combined value of the farm implements, machinery and livestock on American farms. It was fifteen per cent of the national farm wealth in 1920 and an increase of five billion dollars above 1910 figures. With inflation due to war conditions, plus the building done, this meant one-half billion dollars increase, annually, for the decade. With a normal increase since 1920, our farm building investment should be approximately 15 billion dollars today. It must be remembered that while agriculture has been passing through a depression period, material and labor costs for construction have not been lowered under 1920 prices. It does mean, however, that less building has been done on farms, which would indicate a pressing need when agriculture again becomes normal. Figuring a five per cent annual increase—new work, replacements and repairs—means that ¾ billion dollars, or 12½ per cent of the nation's construction work, is spent on farm buildings.

All farm buildings except the farm house have improved in appearance as well as in construction methods. Attractive barns and cribs have replaced the pioneer type. The gambrel self-supporting barn truss is simple in construction and economical in use of materials. Properly laid out, its lines are good and a great increase in storage space is secured. Metal ventilators on ridge and lean-to dormer windows on roof, add much to the appearance. Each have a function. Ventilators draw off foul air from the animal quarters, while the dormers admit light as well as air to the mow space. In careful cost check—labor and materials—I found that four three-sash dormers could be added to the barn at a cost of $80. The agricultural engineer is responsible for this advancement. Stresses in materials, stock lengths and space requirements were the determining factors in barn design.

The farm house has not fared so well because it is more complex. The agricultural engineer realizes that it is a problem for the professional designer. The silhouette must fit the terrain. Roof lines should harmonize with the setting—hills and trees for background, or level open spaces. They may also be in direct contrast. Climate is another factor which helps to determine both plan and exterior. A sunless gray climate requires steep roofs with shallow cornices, while an abundance of sun demands a low roof with a wide-projecting cornice because shelter and comfort are the real needs of a home. Then the materials used help determine the shape and outline. Wood is adaptable to horizontal low exteriors, while masonry as a compressive material is adaptable to tower-like exteriors. In detail, openings add interest to the frame construction, while bond, color and texture add interest to masonry.

Beauty in the farm house may be had by interesting masses, proportions and groupings rather than from ornament and detail. Simple elevations are always preferable. They wear and last, while the fanciful and elaborate soon become tiresome and uninteresting. Ornaments should be limited to cornice and chimney tops, to bring out beauty in the roof. The entrance should express hospitality by its simple ornament. Windows should not have ornament but should have expression and character in their proportion, size and grouping. Simple masses of correct proportion grow more beautiful with age and last for centuries.

Scale in the exterior design should not be overlooked. Large units reduce size, while small units exaggerate it. Clay product units of large size with brick like bond and texture are out of place in the farm house. A feeling of coziness and comfort should be expressed in every farm home.

Interiors, fitted to living needs, such as wall space for furniture or group centers are just as necessary in the farm house as the city mansion. By careful planning, two or more furniture settings may be had for the living room. Then there should be character in the fireplace and mantel shelf, the trim and doors. It should express hospitality and refinement, and not be repulsive. Shapes and sizes of rooms fitted to the needs, such as a rectangular plan for living room, adds to its hominess and charm.

Individuality in the farm home may be had by straightforward use of mass and materials and truthful construction. It should not be achieved by freakish or unprecedented design. Select the material best suited to the purpose and use it in the way it was intended. Make the house express the shelter and hospitality which all seek in the home. Do well what is done, in design, materials and craftsmanship. One should not suffer by the enhancement of another.

The farm house site is usually large and roomy, so there is ample chance in plan to spread out rather than go skyward. The major mass with correct roof lines flanked with subordinate appendages, as porches or additions, help in a wonderful way to remove bareness and to add character to the house. Since the farm house is seen at long range and at varying distances, the light effects of sun, shade and shadow add interest and beauty, which could not be had at close range. Small detail is useless and a superfluity which should be minimized on the farm house exterior.

The color of the farm house should be carefully considered. The setting changes with the season, from neutral values in late winter to vivid greens in early spring, followed by darker greens, reds, and browns as the year advances. White as a basic color, with harmonizing trims, which fit the environment—native trees and planting—should be chosen. Colors of neutral shades for the roof best serve, since they harmonize with the blues, grays and golds of the sky. Vivid colors would be out of place on the roof.

The best planned and most attractive farm homes are the product of many factors. First, there must be sufficient interest on the part of the owner so that he will want and attempt to secure the best. Then, he must have the fullest cooperation of the agricultural engineer, who seeks a commanding, well-drained location, convenience and economy in the building layout and grouping; the architect, who strives to secure correct proportions, attractive groupings and defi-

nite mass in exteriors; and the contractor or builder, who executes the work into a structure of superior workmanship. Therefore, I beg the agricultural engineers, who are men of good judgment, to coordinate and work with the architectural profession. And, on the other hand, I appeal to the architects to show a greater interest in farm home design. As a rule the architects have traveled to European countries for inspiration and could easily inject new blood into farm home designs. The European farm house undoubtedly could give much inspiration for exterior treatment in the modern American farm house. The Dutch farm houses of the Connecticut Valley and of New Jersey were inspired from the ancestral homes in Europe and the southern plantation homes of Maryland and Virginia had foreign precedent.

Why has this not been done? you may ask. There are three reasons: First, the farm folks have been accustomed, for generations, to use local materials and to employ local labor. Higher prices, in recent years, have forced them to feel the value of plans and to use them. Secondly, the architect has been too busy to give the farm building problem much thought. He has been fully occupied with more remunerative work. The agricultural engineer has been busy keeping pace with implement and machinery development and reclaimed acreage for greater production. With the new transportation—hard roads and the motor car—the architect and engineer can make contact with farm life—rural habits, needs and ideals—which were impossible a few years back. When the agricultural depression ends and agriculture is placed on a professional basis, it will be more remunerative and the farm folks will build houses equal to the best in the cities. On the eve of this period, farm life has leaped forward. Surely the farm house will bud and bloom as never before. Now is the time to anticipate this need and take the forward step necessary to meet our obligations. Commercial enterprises have already read the signs and are working earnestly for their share of the business. Some service must necessarily be given and a few materials promotion organizations have rendered signal services in preparing first-class plans for city homes and a limited number of farm homes.

In mill work, attractive doors, in panel, grain and molding, are selected, and simple lines and moldings are used in the trim. Harmonious colors are chosen for walls, furniture and hangings by the farm folks.

Lighting, both natural and artificial, has received more attention. Illuminating engineers have determined the lighting requirements and the artist has designed beautiful fixtures which are available to every home owner. Correct lighting adds personality, comfort and cheerfulness to any house. The farm folks appreciate this advantage.

The location of windows so that light and sunlight is secured adds much to the house. What is more comforting and cheering than an abundance of sunlight on a cold winter day? Attractive landscapes, cultivated fields, distant forests, hills, valleys and winding streams viewed from kitchen or living room are assets to any house. Railroads capitalize on scenic routes. Each of us may recall some view which has made a lasting impression. That sturdy spreading chestnut tree which stood as a lone sentinel, seen some five miles away from the country church door, made a lasting impression upon me. I always paused there to look and dream when leaving the church. I dreamed of its sturdiness, of the two broad valleys with the twenty-odd farms between us; of the district school house, the maple sugar camps and the winding creek with the "ol' swimmin' hole"—I wanted to fly to it and be strong like it.

The farm house surrounded by broad acres, overlooking hill and vale, field, forest and stream, and distant farmstead on the skyline is rich, indeed, in beauty which many of us never see. The house with such surroundings as most of them have should be worthy of and should not mar such a landscape.

And finally nature's richest blessing—vegetation—may be had about any farm house. Trees and plantings do more to beautify than all man may create and execute in mass, form, color or texture. Every farm house should have a setting among trees—native or planted—and shrubbery. Wide lawns, arbors, trellises and low shrubbery with their greens and colors, make an ugly farm house colorful and homelike. Again, this is a professional problem belonging to the landscape architect who is an artist in planting, pruning and grouping. His services complete the setting and bring out the individuality which the farm house must have.

In conclusion, beauty may be had in every farm house if we all work harmoniously toward that end. The farm house is an individual problem requiring careful study on the part of owner, material dealer, engineer, architect, contractor and landscape man. The owner must know his needs; the material dealer provide those materials best suited for color, texture and character. The agricultural engineer provides the farmstead plan, and utility need. The architect studies the massing and parts best suited to the setting. The contractor executes the plans and design into first-class construction, and the lanscape artist puts on the finishing touches by selecting fitting trees and shrubs to bring out the ideals sought by the others. After reaching this perfection the American farm house will take its place in our national life and attain the position which farm folks deserve.

Domestic Air Conditioning

PERHAPS the next and certainly one of the most important of the contributions of science and engineering to the equipment of our homes—and equipment is as much a part of the modern home as its furnishings—will be a device for controlling the humidity or moisture content of our indoor air.

We live in rooms ranging between 70 and 80 deg. F. and wear clothing in which we would actually suffer from heat if there were as much moisture in the air as we normally have in the comfortable weather of late spring and early summer. If instead of increasing the temperature of the air in our rooms we were to increase its humidity to correspond with the normal moisture content of out-of-door air in our temperate seasons, we should find ourselves comfortable at indoor temperatures ranging from 60 to 65 deg.

Beyond its effect on our health, our pocketbooks also suffer from our failure to maintain a proper control of the humidity in our homes. It is estimated that 25 per cent of the cost of heating our houses is incurred in raising the temperature from 62 to 72 deg. F.

We are not without means for controlling either the humidity or the dust and germ content of the air in our homes. It is, however, rather a reflection on our usual tendency to cater to our material comfort, that this equipment was originally developed for industrial processes that demanded a closer regulation of air conditions than those under which our bodies regularly suffer at home. For more than a decade these conditions, as well as temperature and air circulation, have been accurately controlled by the air conditioning equipment in hundreds of industrial plants throughout the country.

More recently the use of air conditioning equipment has been extended to hospitals, theaters, department stores, and office buildings. While it is true that this equipment is both complex and expensive, it is no more so than many of the devices which have been adapted to domestic use, once the need was realized.

In an ordinary house the air change due to leaks about the windows amounts to from one to two complete changes per hour. In order to supply the requisite moisture to bring the humidity of the house up to 50 per cent, the amount recommended by competent medical authorities, an evaporation of one to two gallons per hour is required.—From the Industrial Bulletin of Arthur D. Little, Inc.

Poultry House Ventilation in Washington

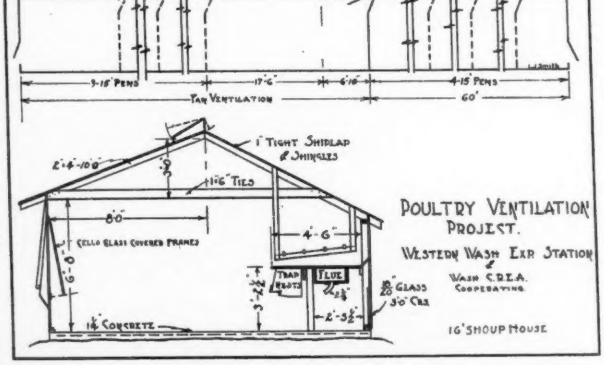
By L. J. Smith[1]

ONE of our most interesting research projects for the past year was poultry house ventilation. This is a real problem on the west side of the state where the air is nearly saturated for a large portion of the winter months. Under such conditions the straw litter becomes damp very rapidly, it often being necessary to change the litter every week. Where the litter is in such a bad condition, the birds do not work over it and therefore do not get their needed exercise. Also the cost of additional straw and the labor required to replace the litter is an important factor in economic egg production. The litter problem is considered one of the most important problems to be solved for west side conditions.

It was proposed that an effort be made to keep the straw litter dry by means of warming the air used for ventilation purposes. In August 1926 a ventilation system, designed to attempt to solve this problem, was planned and installed in one of the poultry houses at the Western Washington Experiment Station at Puyallup. During this fall another system of ventilation has been installed in a 24x24-ft. unit of the large laying house on the poultry farm of the State College of Washington at Pullman.

The ventilation system at the Western Washington Experiment Station was installed in the south house which is 16 ft. deep. This house had eight pens, seven of them being 15 ft. long and 16 ft. deep and the eighth somewhat larger. Four of the 15-ft. pens were separated from the others by a tight partition, these pens being given the natural ventilation common to the Shoup house. The remaining four pens were given ventilation by means of a 7½x18-in. flue running underneath the dropping boards with the dropping boards forming the upper surface of the flue as shown in the drawing. Two 2¾-in. 30-degree downspout elbows were used in each pen to direct the heated air down on the litter. It was planned also to put smaller flues vertically through the bottom of the flue to blow a smaller portion of air down on the litter underneath the dropping boards. This, however, was not found necessary. The air was heated in a small blower room 4x6 ft., the inside walls of which were lined with asbestos paper. The fresh air came into the room at floor level and made three right-angle turns before it reached the stove which was used for heating. The brooder stove operated with distillate and when used automatically kept the temperature of the blower room between 78 and 82 deg. F. A No. 1 B Western Blower Company turbine multiblade fan was used in the experiment, being driven by a direct-connected ¼-hp., 750 r.p.m. "Century" electric motor. When it became sufficiently cold and rainy so that the ventilation system was needed, the long continuous curtain was dropped over the open front of the four pens having the fan ventilation, and the outgoing air passed up through the ventilator to the room.

[1]Professor of agricultural engineering, State College of Washington. Mem. A.S.A.E.



Plan and cross-sectional view of Shoup poultry house in which the ventilation research project was conducted at the Western Washington Experiment Station

A preliminary test of the ventilation system in December 1926 showed that it provided the necessary amount of air per hen. The test showed that each bird received a little over 50 cu. ft. per hr. of air, which is a higher figure than that recommended by most poultry authorities. Another interesting fact was brought out, namely, that the elbows in the far end of the warm air flue gave more air than those nearest the blower room. Since the anemometer used in the test was almost in the same diameter as that of the elbows, it made the test very accurate. The velocity of the warm air leaving the elbow nearest the blower room was 681 ft. per min., the velocity at the second elbow from the blower was 741 ft. per min., the velocity at the last elbow, farthest from the blower room, was 813 ft. per min., while the velocity from the elbow next it was 803 ft. per min. This test showed that, if the flue were made sufficiently large, the velocity at the outlets farthest away would always be greater than those nearest the blower room. The temperatures of the air leaving the first and the third elbows from the blower room were 65 and 64½ deg. F., respectively, while the temperatures of the air leaving the sixth and eighth elbows from the blower room were 62 and 58 deg. F., respectively. During the period of these temperature tests the temperature in the blower room ran between 78 and 80 deg. F. Last winter's tests with this ventilation apparatus proved that it could keep the litter dry. The straw in the pens on the fan ventilated side was only changed once a month (which is the practice followed in the summer) and during that period was kept in a satisfactorily dry condition. When the fan and heater were operated during the night while the birds were on the roosts the litter was well dried out for them when they came down in the morning. Unfortunately the birds in the ventilated pens showed a somewhat larger proportion of small eggs, which had a considerable effect on the income. It scarcely seems possible, however, that the difference in ventilation would affect the size of eggs. Summarizing the results of egg production for the ventilated pens, as against those having natural ventilation, on the basis of the number of dozens of eggs produced, would seem to be a fairer method of comparison.

During the past summer Cell-O-Glass covered frames hinged at the top were placed over the continuous open front of the four ventilated pens, the idea being that these could be dropped down during extremely rainy or cold weather, making it possible for the ventilating system to provide more of the fresh air coming into the house. These frames should also make the pens somewhat warmer. The project is being continued during the winter of 1927-28 under the direction of George Shoup[2]. Mr. Shoup has also installed a coal heater in the blower room in place of the oil heater with the idea of cutting down the cost of heat, which is the big factor in the ventilation system. A complete report of the project will be made at the end of this winter's experiments. A report of the ventilation system at the college will also be made at the end of the experimental period.

The ventilation tests started December 1, 1926. The production percentages of the two lots of birds for November, the preceding month, were almost identical.

The birds on the ventilated side laid 1.7 per cent more

[2]Poultryman, Western Washington Experiment Station

eggs in December, 5.0 per cent more in January, 0.3. per cent more in February and 6.8 per cent more in March. They apparently came through the winter in a little better physical condition as evidenced by their continued heavier laying after the ventilation was discontinued April 1.

One period of freezing weather in December demonstrated that the control of heat and moisture conditions is a decided advantage. It appears that one degree increase in heat decreases the moisture content of the air about four per cent.

One other decided advantage of the heated section was that the droppings were never frozen to the dropping boards, and the milk, water and green food were never frozen. In the unheated section the droppings accumulated in a frozen mass, during the three days of continuous cold, and all the liquid foods had to be replaced or thawed out frequently. The litter remained dry fully as long as in the summer time and lasted an average period of thirty days in this heated section, while in the unheated section the straw had to be changed at least twice a month. When it was renewed it had accumulated 60 per cent more weight of moisture than the heated section had in twice the number of days.

The experiment has demonstrated that the heat and moisture conditions can be controlled adequately with no injury to the health of the birds with the forced ventilation plan used, and that this inexpensive equipment holds promise of being a practical method whereby the poultryman may conduct his business satisfactorily regardless of weather conditions. It was always possible to keep the heated section several degrees warmer than the non-heated section. The self-registering moisture hydrograph could not be operated outdoors in the winter time. Each foggy night the marker climbed clear over the top of the chart.

It should be mentioned that feeding experiments were run in this house using four different rations; but each ration was used in a pen in the forced ventilation section and one in the natural ventilated section, as nearly as possible the same number of birds being kept in the corresponding pens.

AUTHOR'S NOTE: The author is indebted to George Shoup for his assistance in keeping the necessary records and compiling the data obtained. It should also be noted that the figures given are for the first year only. The experiment will probably be run for two more years.

An Underheat Electric Brooder

By Harry L. Garver[1]

THE design of the underheat type of brooder described in this article, with resistance wire under the sand tray, originated with George Quinan, chief electrical engineer of the Puget Sound Power & Light Co., of Seattle. In the first plan the warmed air came up into the space used by the chicks through two centrally located chimneys.

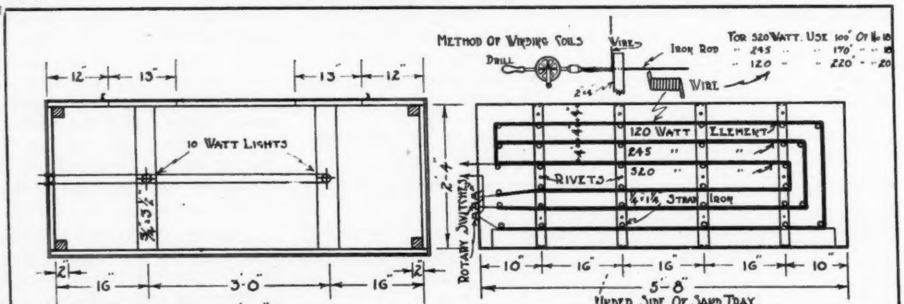
In order to assist the upward movement of the air underneath the hover and to cause a more uniform ventilation throughout the brooder, the author planned a three-inch slot running continuously along the back of the brooder for the chimney. One-half of the lowest wattage coil is located in this chimney space and is not turned off during the entire period of brooding. This insures a slow continuous movement of warm air under the hover.

The heating units are controlled by three switches, which allows a wide variation in the amount of heat applied. The heat was regulated manually, but it may be that a more economical installation will result in the controlling of the two highest wattage heating elements by means of a thermostat.

Note in the accompanying drawing that 10-watt lights are located on the under side of the hinged top. These lights are sufficient to cause the chicks to spread uniformly over the sand tray. If the electricity happens to be off for three or four hours, the two inches of warm sand will provide sufficient heat so that no bad results will be noticed.

The brooder shown in the accompanying illustration was operated for a period of eight weeks during the brooding season last spring on a practical poultry farm near Yakima, where it proved very satisfactory. Two hundred and two day-old chicks were placed in the broder, and two hundred were successfully brooded. The total energy consumption for the eight weeks period was 100 kw-hr. The outdoor temperatures averaged 56 deg. during this period.

[1]Rural electric investigator for the State of Washington, State College of Washington. Mem. A.S.A.E.



This drawing shows the details of the Washington underheat electric brooder that has been developed by Mr. Garver in connection with the rural electrification project being conducted by the Washington Committee on the Relation of Electricity to Agriculture

Recent Changes in Tractors as Noted from the Nebraska Tractor Tests*

By H. L. Wallace[1]

THE year 1927 has been a notable one in several respects in the tractor testing work at the University of Nebraska. We have tested the largest number of tractors this year since the testing work was started, with the exception of the first year, during which sixty-four tractors were tested requiring a testing crew of twelve men. Sixteen tractors were tested during 1927 with a crew of three men. We tested this year both the largest and the smallest tractor of the entire eight years of testing work. The small tractor exerted a maximum drawbar pull of 140 lb. and the large one a maximum pull of 20,050 lb. The problem of furnishing a load that could be applied in suitable increments was a rather serious problem.

In order to test the small garden tractor a special loading machine was built. This machine consisted of a Chevrolet chassis without the engine. A small gear pump was connected directly to the transmission in place of the engine. Therefore, when anyone of the four speeds of the transmission were engaged with the car moving forward, the pump was set in motion. A supply tank was connected to the pump by two pipe lines. The pressure or return pipe has a valve in it located conveniently to the operator of the car. By the manipulation of this valve the proper load can be maintained, also an increment of loading can be applied as low as five pounds if desired. The fact that the clutch can be disengaged until the tractor gets up momentum is an important feature in this machine. During the maximum drawbar test of these small tractors it was found that at the maximum pull an increase of ten pounds in the load would stall the tractor. Thus the desirability of a loading machine in which small increments of loading can be applied becomes evident.

Quite a different experience was encountered in testing the large tractor. Here the problem of getting sufficient load was a difficult one. Few people realize the amount of resistance needed to create a 20,000-lb. drawbar pull, especially when such resistance is of a rolling nature. The loading apparatus used in the maximum drawbar test of the large tractor consisted of a large steam tractor placed in reverse gear with the piston working against about 65 lb. air pressure in the boiler and furnishing about 9,000 lb. drawbar pull, a dynamometer car yielding about 4,500 lb. and two old Avery tractors—one with all four wheels tied and the other with the rear wheels tied—supplying about 3,500 and 3,000 lb., respectively.

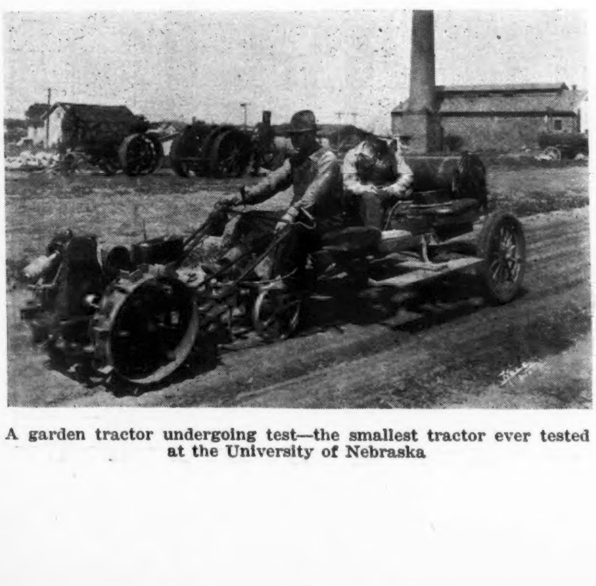
The problem of securing the crankshaft speed of the tractor engine during the drawbar test is a problem that has given us much concern. We have not yet discovered any universal method of connecting a direct-reading tachometer. To connect such a tachometer to one certain tractor is perhaps a simple matter but owing to the many designs of tractors a universal coupling is practically impossible. The accompanying illustration shows one that has more nearly given universal service than any other type that has come to our notice. On all wheel tractors the attachment is comparatively simple. In fact, we have had but one machine, of the one hundred thirty-five different models, on which this counter could not be made to operate. The fundamental principle of this counter is in the making and breaking of an electric circuit, which in turn operates a magnetic counter. This counter gives the revolutions of the shaft to which it is attached. When the counter is attached to the drivewheel a ten-point circuit breaker is used which gives the revolutions of the drivewheels accurately to one-tenth of the revolution.

In order to determine the revolutions of the crankshaft the following formula must be used: Gear ratio times revolutions of the drivewheels divided by the time in minutes during which the counter was in operation.

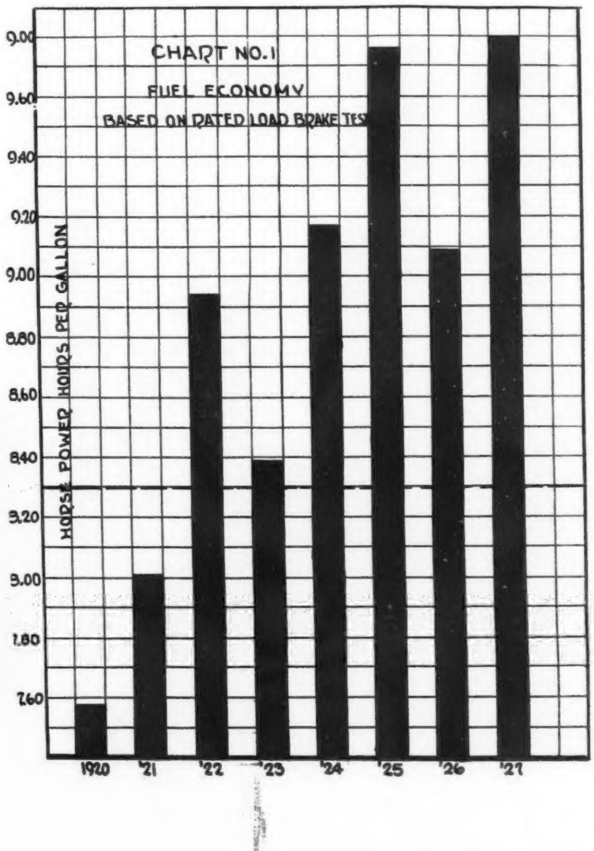
The advantages and disadvantages in using this counter on drawbar testing work are as follows: The engine speed cannot be determined until after the test is completed, at least a maximum test which is of comparatively short duration. Therefore, in running the maximum test a cut-and-try

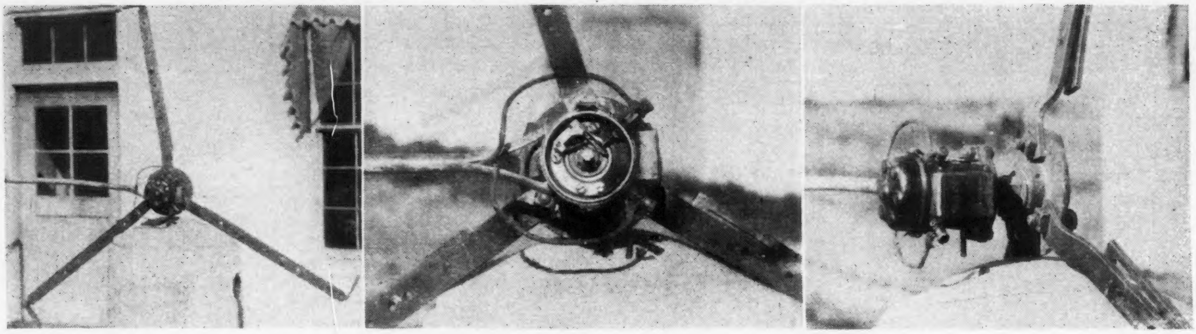
*Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1927.

[1]Engineer in charge of tractor tests, University of Nebraska. Mem. A.S.A.E.



A garden tractor undergoing test—the smallest tractor ever tested at the University of Nebraska





Three views of the tachometer used in the University of Nebraska tractor tests to get the crankshaft speeds of tractor engines

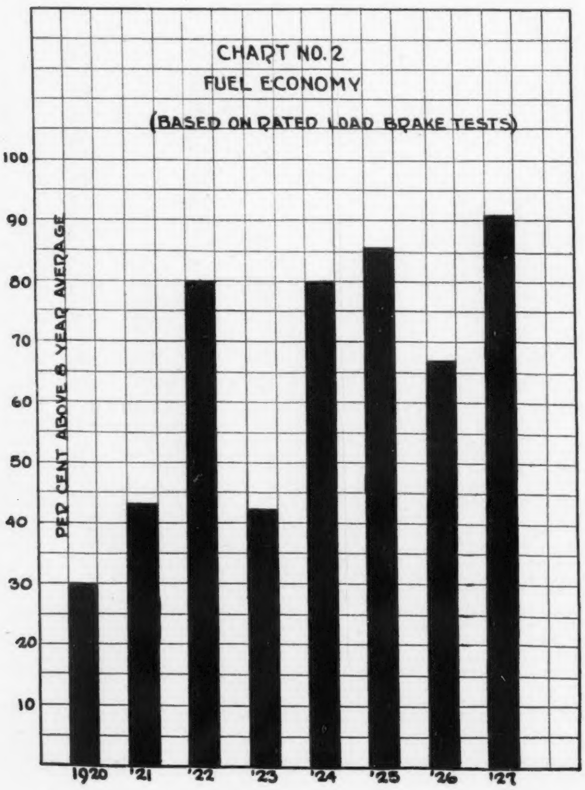
method must be used, that is, if the engine speed is either too high or too low another trial must be made with the proper change in load. The chief advantage of this counter is that the slippage of the drivewheels may be determined as well as the calculation of the speed of the engine.

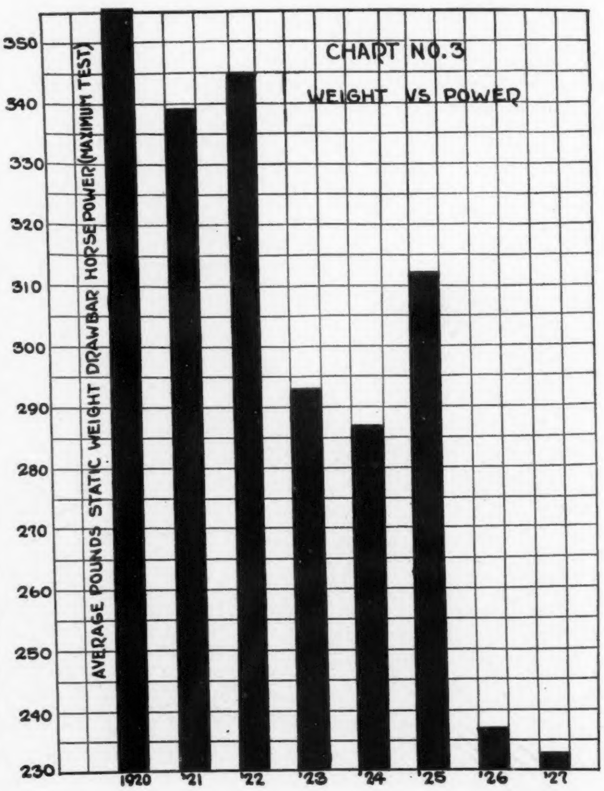
There has been a very marked improvement in tractors since the tractor testing work at Nebraska was first started, and more especially the last two years. Our present-day tractors show more economical fuel consumption than those of only a few years ago. Chart No. 1 gives the fuel economy record by years of the tractors that have been tested at Nebraska. Each graph is the average of all tractors tested that year. It is interesting to compare the years 1920 and 1927. The tractors of 1920 developed 7.56 hp. per hour per gallon of fuel as an average, whereas the tractors of 1927 had an average of 9.80 hp. per hour per gallon of fuel. The average fuel consumption for the eight years of testing is 8.30 hp. per hour per gallon of fuel. Chart No. 2 shows the same superiority of our modern tractors over the earlier tractors in the economical use of fuel. This chart was developed by calculating in per cent the number of tractors during the year that were above the eight-year average. It is to be noticed that 91 per cent of those tested in 1927 had a better fuel economy record than the eight-year average, whereas but 30 per cent of the tractors tested in 1920 had a better record than the eight-year average. Therefore, our records here at Nebraska show the 1927 tractors to be much more economical users of fuel than any preceding models. Of course, this is speaking in general terms rather than comparing individual models.

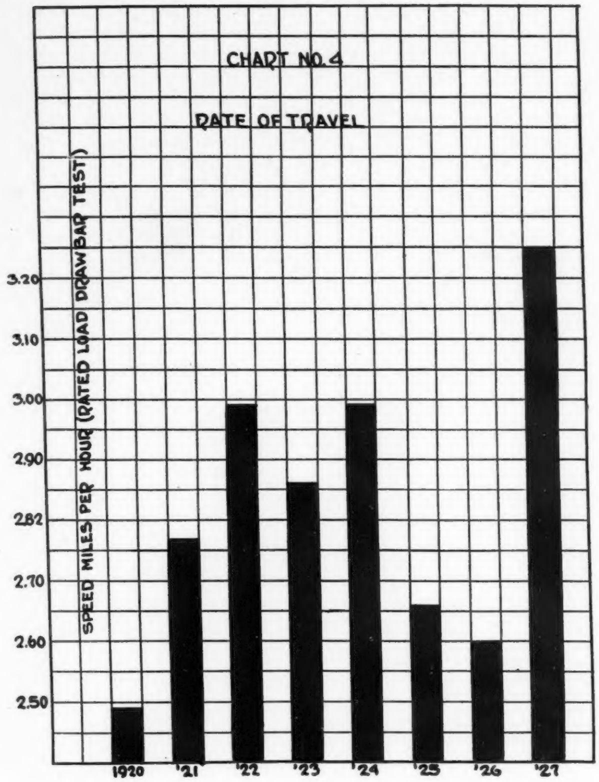
Our modern tractors are more powerful for the same weight than the earlier models. This is shown quite clearly in Chart No. 3. Each graph was produced by taking the average weight and dividing by the average maximum drawbar horsepower developed for each year. Thus it is shown that in 1927, one horsepower was developed for each 233 lb. weight as compared to 356 lb. in 1920.

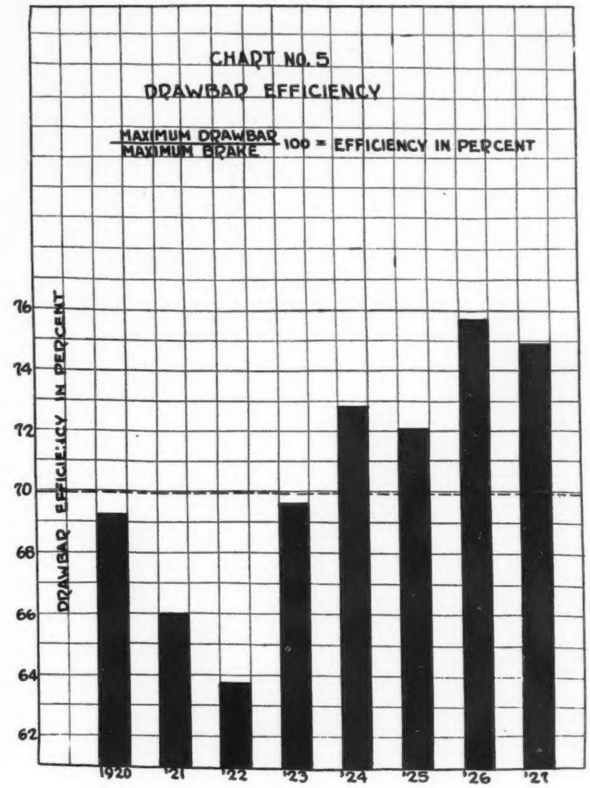
Chart No. 4 gives the average rate of travel for each year since the testing work was started. This data was compiled from the ten-hour rated load test.

The drawbar efficiency of the tractors of the last four years shows a marked advancement over those of the pre-









ceding four years. This increase in efficiency is undoubtedly brought about by the introduction of machine-cut gears for the transmission which are enclosed in a dustproof case and run in an oil bath. Also the adoption of roller and ball bearings has played an important part in reducing friction.

Summarizing Charts Nos. 1, 2, 3, 4 and 5, we find the tractor of today more economical in fuel consumption, lighter in weight per horsepower developed, and faster in rate of travel. The increase in rate of travel enables the operator to do more in a given length of time. These charts are all based on actual test data.

In addition to the improvements already mentioned we find the present-day tractor more accessible for repairs, better designed, equipped with air cleaners, and neater in appearance.

It is interesting to note the change in attitude towards the testing work. When the testing was first begun, maximum power output seemed to hold the attention of both the manufacturer and the user. Now the pendulum has swung to economy. I have heard several manufacturers during the past season say in substance "We have ample power but are very anxious to show good fuel economy." This change is also observed in inquiries from farmers.

Since the larger percentage of work done by the tractor on the average farm is drawbar work and since fuel economy is a timely issue, it is interesting to note the comparison between the rated brake load and the rated drawbar load tests conducted at the University of Nebraska. The drawbar efficiency for 131 tractors was found to be 69.9 per cent, the fuel economy 8.30 hp.-hr. per gallon on the rated brake load and 5.07 hp.-hr. per gallon on the rated drawbar load. Since the mechanical efficiency in the matter of power developed was found to be 69.9 per cent, whereas the use of fuel is only 63.3 per cent efficient, wherein lies the difference?

Charts Nos. 6 and 7 are sample maximum drawbar charts. Both charts are identical except Chart No. 7 has the three horizontal lines drawn through it, the center one representing the mean height of the stylus above the base line and the other two lines being fair averages of points to which the stylus rose or fell depending on the load. Chart No. 6 was presented to show that the variations in load are not nearly so obvious until the straight line was drawn, from which the eye readily gages the stylus variations. These two charts compare very favorably with charts taken during the plowing of any ordinary field, so far as the variations in draft are concerned. During the process of taking Charts Nos. 6 and 7 the operator of the dynamometer attempted to hold a constant load, but the factors which finally determined the load as recorded by the stylus did not lay within the control of the operator, namely, slippage of the drivewheels both on the dynamometer car and on the tractor. These charts are not presented as representative samples of our maximum charts, but rather to show that our drawbar loads are never constant in the sense that our brake or belt-testing loads are. We have, on the other hand, a surging load varying almost constantly, possibly not between as great extremes as shown in Charts Nos. 6 and 7 but possibly even greater than shown in these charts.

This very likely accounts for the lower efficiency of the fuel consumption as compared to the mechanical efficiency. Furthermore, from our observations we have never been able to get the tractors to operate satisfactorily on the rated drawbar test at the same carburetor adjustments as those used on the rated brake tests. This requires that the needle valve be adjusted for a richer mixture. It is extremely doubtful if the ordinary tractor operator working under average farm conditions can secure the fuel economy procured on our rated brake load tests. Therefore, the tractor testing board at the University of Nebraska is seriously considering changing the rules governing the tests, in that we will have one carburetor setting for all tests instead of adjusting the carburetor for each test as we do at the present time.

Charts Nos. 8 and 9 were prepared with this object in mind. Should the above mentioned rules be changed as suggested, the adjustment of the carburetor should be one that permits the tractor to pull a rather high percentage of its ultimate power with fairly good fuel economy. Chart No. 8 shows the characteristics of the fuel economy curve on two different tractors as the ultimate maximum torque is reduced at one per cent intervals. It is to be noticed that there is quite a marked difference in fuel consumption at about 96 to 97 per cent of the ultimate maximum. The small

tables given in Chart No. 8 reveal that reducing the torque 97 per cent decreases the horsepower output approximately 1 hp. but reduces the fuel consumption approximately 5.7 lb. per hour. Or, in other words, it requires 5.7 lb. of fuel to produce 1 hp., which is very excessive.

The matter of one adjustment of the needle valve of the carburetor for all operating conditions is not a new proposition to the automotive world. Pleasure cars and trucks have been on this basis for some time.

The proposal under discussion seems to have the following points favoring its adoption:

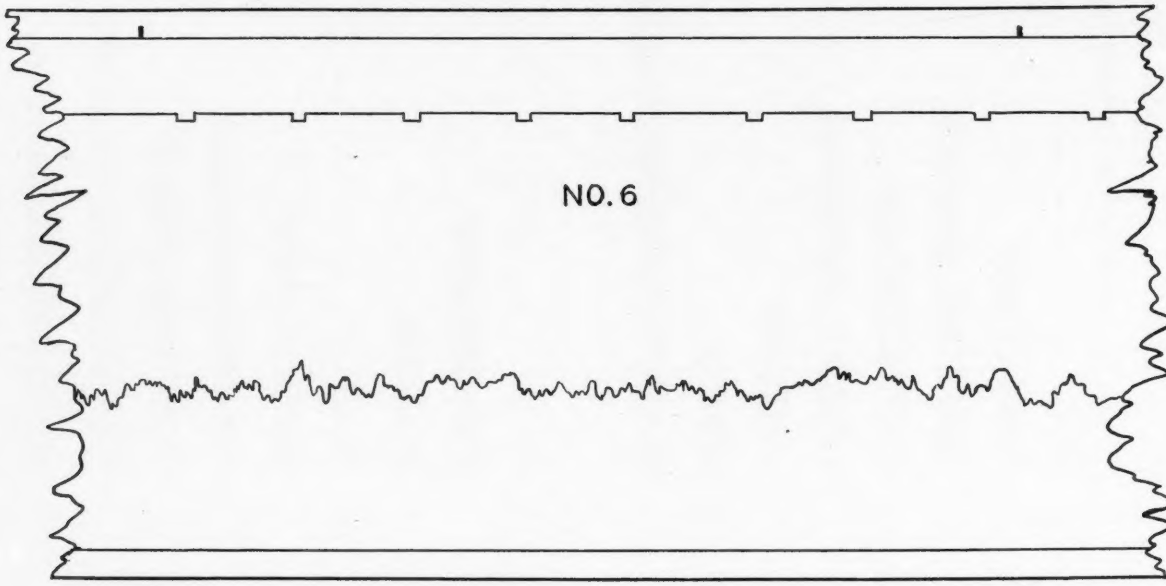
1. It will make the results of our tests at the University of Nebraska more nearly correspond to the results obtained under actual field conditions.

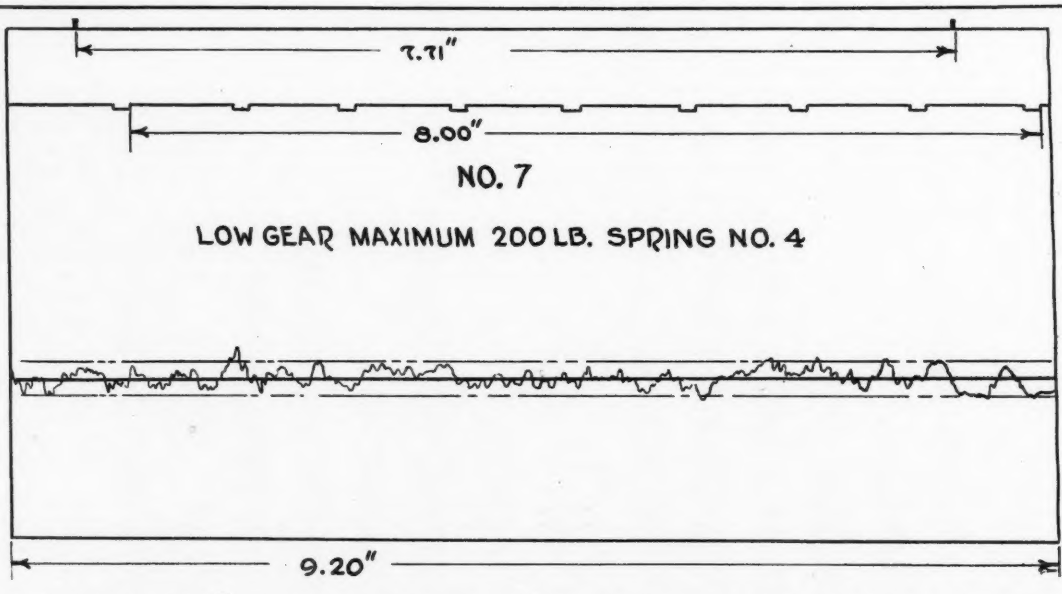
2. It will give the carburetor manufacturer a definite basis upon which to design his carburetor, whereas under present conditions one tractor concern may demand maximum power output regardless of economy, another may demand maximum economy regardless of power output, etc.

3. It will simplify our testing procedure.

4. It will permit more uniform treatment of all tractors.

The results of tests at Nebraska have been checked according to the provisions of the farm tractor rating code of the American Society of Agricultural Engineers for the last



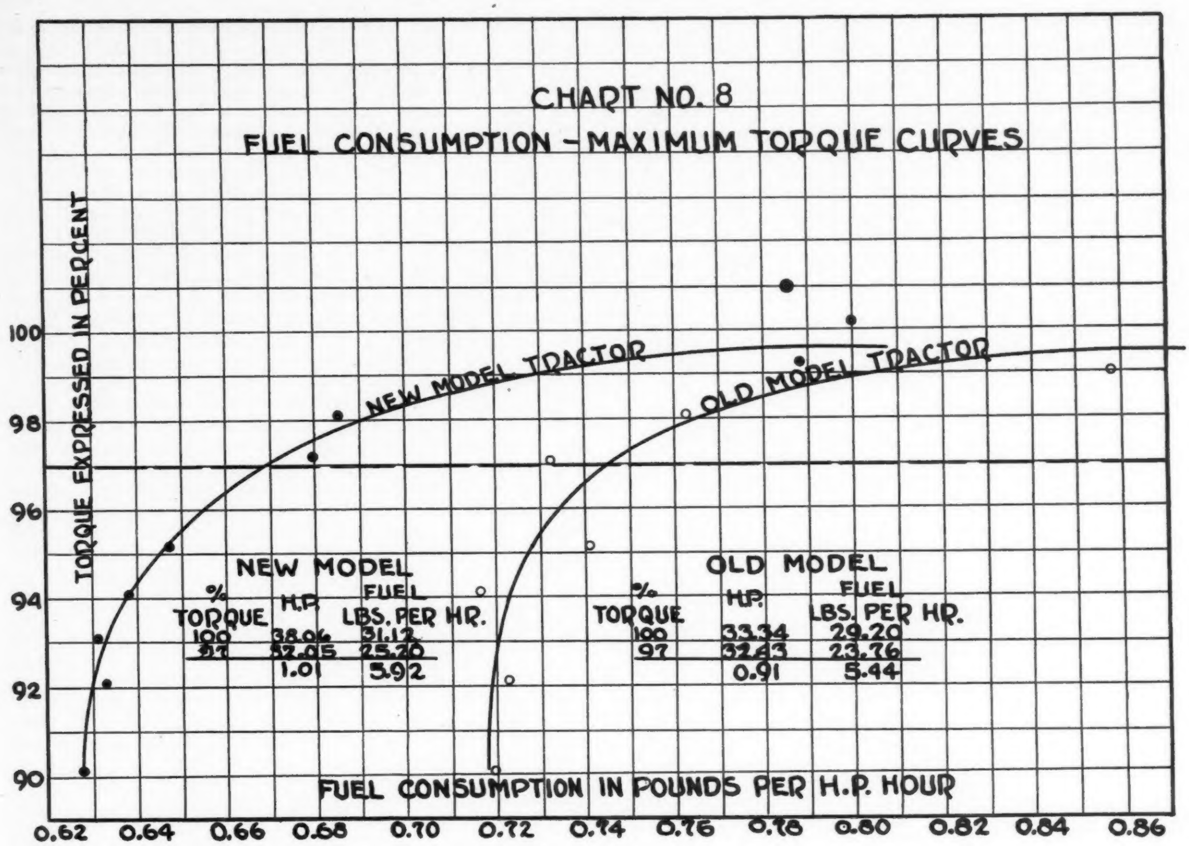


AREA = 12.930 □"   12.930 ÷ 9.20 = 1.405" MEAN HEIGHT   1.405 × 4000 = 5620 LBS.

$\frac{8.00}{7.71} \times \frac{400}{2}$ = 207.5 FT. PER MIN. 2.36 MI. PER HR. $\frac{2075 \times 5620}{33000}$ = 35.34 H.P.

SLIPPAGE OF DRIVE WHEELS 42.7 IN 400' = 9.65%

POINTS ABOVE MEAN HEIGHT = 0.18" = 720 LBS. POINTS BELOW MEAN HEIGHT = 0.16" = 640 LBS



two years. Only two tractors tested within that time have failed to meet the provisions of the code rating.

A more complete adoption of this code by the manufacturers will do a great deal towards bringing about a uniformity of rating of tractors. There is some confusion and misunderstanding among tractor users and prospective tractor buyers on the matter of tractor rating. We have a good many inquiries from farmers on this subject. It is rather difficult to explain why two tractors of apparently the same maximum output should have a different rated load.

No special weakness in tractors has developed during our tests of the last two years, which might be termed common. However, some constructive criticism should be made along the lines of convenience in handling the tractors, making necessary adjustments, and the comfort of the operator. The inaccessibility of some of the adjusting devices should be given some attention, especially those adjustments that are likely to be made while the tractor is in operation. Tractor seats, for the most part, are really uncomfortable. No doubt most any kind of a seat could be endured for short intervals, but when the long hours which many tractor operators use their machine are considered, an uncomfortable seat becomes noticeable. Another factor which contributes to the discomfort of the operator is the location of the exhaust pipe. In some cases the heat from this pipe almost roasts the feet of the operator, while in others the fumes of the gases are continually being blown into his face.

We are confronted with a problem that is becoming more serious each year, namely, a tendency on the part of manufacturers to wait until fall to submit their tractors for test. We do not have the facilities to handle this rush and, therefore, are seeking some solution of the matter. During the months of July and August our testing plant is practically idle. No doubt it is to avoid the hot weather of the summer months that the models are submitted in the fall of the year. We would like an expression from those interested in this matter as to whether the following would relieve the fall congestion: To incorporate in the final report the maximum horsepower corrected to standard barometric pressure and temperature, such notation to be labeled "corrected horsepower."

Discussion

In the discussion following the foregoing paper, L. B. Sperry, tractor engineer, International Harvester Company, analyzed both the tractors submitted for test at Nebraska from the beginning in 1920 up to the present, and also the listings of all tractors on the market during the same period and noted a consistent trend toward the four-cylinder type.

He observed that the tractors tested in 1927 as compared with those tested in 1920 showed about 30 per cent more power developed per gallon of fuel, and that 91 per cent of the 1927 tests equalled or bettered the average fuel economy of the eight-year period, a commendable trend. Calling attention to the increased ratio of drawbar to maximum brake horsepower and the increased relation of horsepower to tractor weight, he expressed the belief that these as well as fuel economy will continue to be improved.

But Mr. Sperry thinks that the rate of travel per hour which has reached a high point of 3¼ mi. is due to decrease slightly. He touched on the effort being made rather generally to improve carburetors and manifolds for the better handling of heavy fuels, and in that connection referred to the confusion and sometimes calamity which arises from the word "distillate" which means such a wide variety of things that it means nothing. Supporting one of the points made by Mr. Wallace, and constituting the peroration of his remarks Mr. Sperry said:

"We have been congratulating ourselves that we are making an improvement in the tractors and giving the farmer a pretty good job. But we are asking him to sit upon a steel contraption that is almost as good as the pillory. And we expect him to ride that all day out in the dust, heat, sun and rain and then get down and thank us for building such a sturdy tractor. Now we can give him a sturdy frame

for his tractor, but I think if anybody deserves any thanks it is the Deity for giving the operator such a sturdy frame to be able to ride on it."

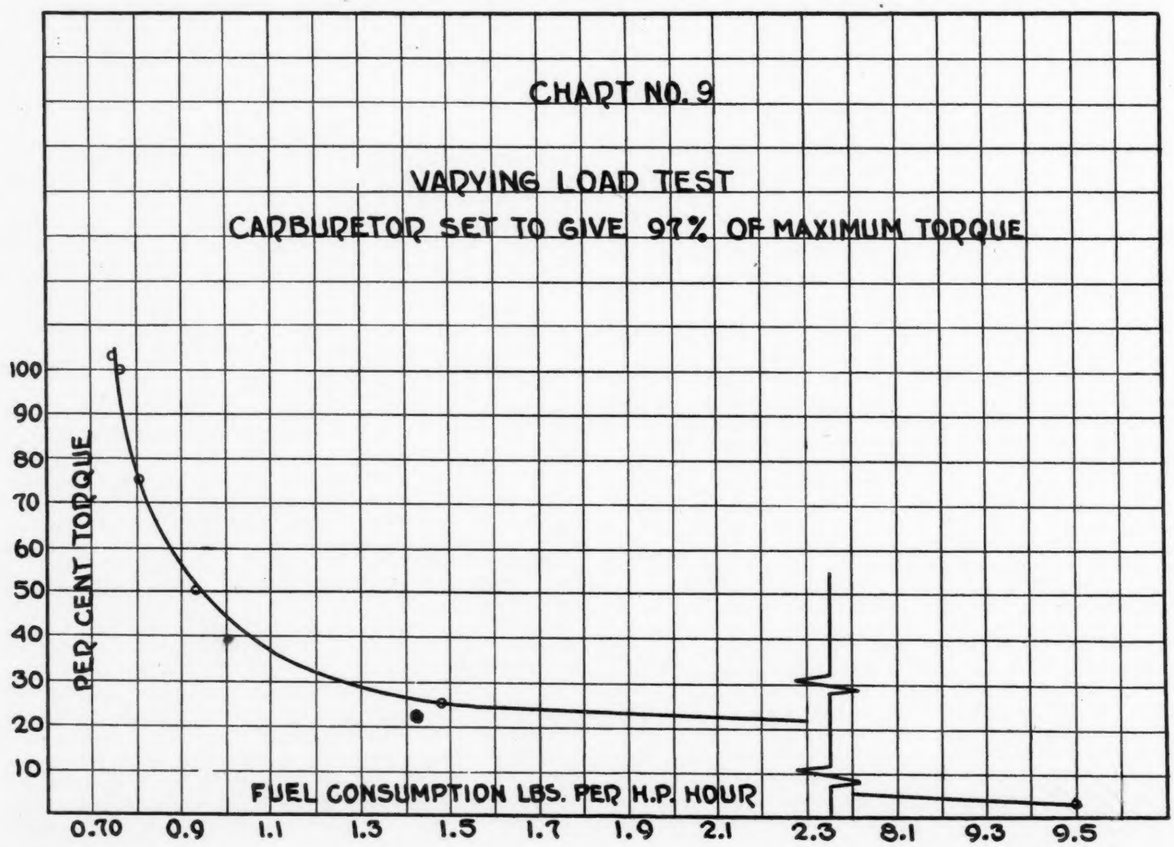
W. H. Worthington, chief engineer, Battle Creek works, Advance-Rumely Company, passed on to other phases of the subject, mentioning a distinct tendency by all the manufacturers to employ materials and manufacturing costs more economically by getting more horsepower out of a given number of pounds weight than ever before. He gave particular emphasis to the fact that the greatest advances now being made in tractors are not in the features of design, obvious to any observer, but in the manufacturing processes whereby tractors of any and every design are made more durable and efficient than in former days, mentioning as an example that the way in which piston pins were ground not long ago would today be considered a very rough job, and that piston pins are now finished by a method which a few years ago was applicable only to gages. In spite of this it is sometimes said that tractors are not made as well as formerly, but this is explained by the wider use and less skilled handling to which the machines are subjected.

On the matter of fuel Mr. Worthington emphasized Mr. Sperry's remarks about distillate, saying that the name covered products ranging from something considerably better than the average kerosene to a product that is almost a fuel oil. He thinks it probable that for many years the oil industry will furnish distilled fuel lower both in grade and price than gasoline, and desirable for use as tractor fuel in engines suitably designed. There probably also will be two other classes of fuels which the engine designer must keep in mind, that is, he must design his engine for some one of three types of fuel, the other two being ordinary motor gasoline or natural gasoline, pretty much the same thing as has been the standard automobile fuel for some years, and the newer anti-knock gasolines which require special features of engine design, notably higher compression, to take full advantage of their properties. He looks for much progress in this class of fuel.

Referring to Mr. Wallace's suggestion that tractors be put through all tests on a single carburetor adjustment, Mr. Worthington voiced the opinion that it was not an immediate but a rather near practical requirement, as the wider and wider use of tractors involved operators of less and less technical skill. He looks for additional progress in the exclusion of dirt from operating parts. While the gears and other transmission parts are pretty well protected and require very little care or maintenance, the air cleaner problem has not been solved and will not be solved for some time. The matter of crankcase ventilation, now a feature of automobile advertising, is a point on which much more progress is necessary in the tractor field, particularly when low grade fuels are involved. As regards accessibility, progress has been backward, simply because the complete enclosure of working parts has made them hard to get at; in fact, getting to the job is considerably more work than doing it.

Mr. Worthington closed his remarks with the statement that competition is too keen and too capable to offer any manufacturer much hope of widening his market by taking business away from the other fellow, while the replacement market is too small to offer promise. Expansion of business, therefore, must come through applying suitable engineering to farm problems and methods so as to expand greatly the range of work which can best be done by tractor power.

Differing quite frankly from both the preceding speakers, even though one of them is his company associate, President Zimmerman of the Society took the position that as regards fuel we are at the crossroads. His view is that there is no future for the crude oil type of engine, based on the fact that all oil companies are working along the line of producing from the crude a larger and larger percentage of the lighter constituents, mentioning that the cracking processes have reached a point where as high as 80 per cent of the crude has been made into high-grade gasoline. He believes that the advantages of these lighter fuels from the



operator's standpoint are so great as to warrant their use even at a slightly higher cost. This view of things is supported not only by the progress now being made in the oil industry, but by the fact that this is essentially a chemical engineering problem—and the chemical engineer is making tremendous strides and accomplishing marvels in many and diverse industries. Col. Zimmerman believes that the conversion of most of the crude into high quality fuels not only is technically and economically feasible, but that the chemical engineers are thoroughly competent to work out the processes.

H. E. McCray, engineer, Deere and Company, developed the fact that although originated as a service to the farmers of that state, the Nebraska tractor tests now are accepted as conclusive not only nationally but internationally, mentioning a visitor from Czecho-Slovakia, who could not speak English but had in his pocket Becker's "Analysis of the Lincoln Tests," printed in German. This world-wide recognition implies an obligation so to conduct the tests that results as issued will be strictly comparable. Consequently Mr. McCray commended warmly the proposal to correct the test results both for barometer and temperature.

Similarly supporting the proposal to make all tests at one carburetor adjustment he said that most farmers could not and neither they nor the men present would operate a tractor with the carburetor adjustment whereby maximum economy records have been made. He thinks this leads naturally and properly to complete revision of carburetor characteristics so as to permit, with one setting, maximum power development and good economy at less than maximum load. He added that even humidity has a part in influencing power development and economy, and that all these factors should be taken into account in arriving at published results. Mr. McCray looks for tractor development of the immediate future to be in two principal directions, one for the wheat belt and the other for the motorization of row-crop production.

D. C. Heitshu, of the Virginia Polytechnic Institute, pointed out room for improvement in steering gears, both by remedying designs which "are so reversible that if you don't hold on tight you are liable to lose anything from a thumb to half an hour," and by improving the geometry of the steering system so as to reduce the horsepower required at the steering wheel. He criticized also designs in which it is necessary for the operator to stand up to reach certain of the operating levers.

Touching on the subject of low grade fuels, E. W. Lehmann, of the University of Illinois, mentioned a case which had come to his notice, involving a farmer using three tractors of the two-cylinder type. This man collected discarded crankcase oil without any purchase price, mixed it with gasoline which, due to a gasoline war, he bought at 12 cents, and reported that it made a fine fuel.

Possibilities of Guayule Rubber

FARMERS in southwestern United States and northern Mexico may soon be growing rubber on an extensive scale in competition with the product of the tropical rubber tree. The plant which they will cultivate as the source of this rubber is a shrub called guayule.

Guayule rubber has been produced for more than twenty years, but owing to its inferior quality and limited production it has not thus far been an important competitor of plantation rubber as produced by the Hevea, or rubber tree. It has recently been announced, however, that it is now possible to produce rubber from this source as high in quality as the plantation rubber. Experiments in improving and adapting the guayule plant have also been successful as far as they have gone, and it may become the source of twenty or more per cent of the world's rubber supply.

An article which appeared in the English edition of the September, 1927, "Pan-American Magazine" describes this rubber and its production. The following quotations will be of particular interest to agricultural engineers.

"It is well known that the Hevea can not be raised in temperate climates, because that tree will flourish only in frostless, tropical latitudes. With the advent of the new guayule product, however, the need of tropical areas disappears, for the shrub thrives in temperate and subtropical climates. It not only withstands frost but requires it.

"The wild guayule shrub, little more than a weed, is indigenous to northern Mexico, extending over a bit into the Big Bend of the Rio Grande in Texas. It flourishes in altitudes ranging from 4,000 to 7,000 ft. above sea level, where the rainfall is 7 to 14 in. annually, with considerable dry periods every year. It has never been found growing naturally outside this area, which in extent, occupies some 130,000 sq. mi.

"In central California 200 acres of the guayule shrub have been planted. So successful have been the results that an additional 600 acres are about to be set out.

"It is the aim of those responsible for the studies already made that guayule growing shall be in the hands of the individual farmer and landowner, whose planting, cultivating and harvesting operations will be guided and financed by the central factory organization in his vicinity. This central factory will buy and mill his product in much the same manner as the sugar industry is now conducted. Supplied with seedlings from the central organization, the farmer will plant, say, a quarter or a fifth of his total guayule area each year, depending on the type of land he happens to own. Since it takes about four years for a shrub to mature ready for harvesting (uprooting), this rotating process will practically iron out labor peaks and will furnish a regular income.

"It has been found that the guayule shrub will continue to manufacture and store up energy in the shape of rubber within its cells even if for any reason, such as an unfavorable market, it is not harvested on scheduled time. Conversely, it may be harvested earlier if there is sufficient incentive, such as a high market or national emergency. In these respects it differs from almost any other agricultural product and promises to be an attractive crop and most acceptable to the farmers.

"In the California plantation no irrigation is employed, and it is expected that none will be necessary on any of the farms that may add guayule growing to the list of their products. The spacing of the plants is designed with special reference to the root system, which will exhaust at a given period the available moisture remaining in the soil after the winter rains. * * * * *

"A good average shrub will yield from 14 to 16 per cent of rubber. The rubber thus obtained is of the same chemical composition as Hevea rubber, except that in the mechanical process of extraction approximately 20 per cent of resin is incorporated with the pure rubber. In many manufacturing compounds this resin serves a useful purpose, replacing softening agents that would otherwise have to be milled into the harsher Hevea rubber.

"Considering the economies of production, it has been the aim of the California experimenters to make guayule a machine-grown, cultivated, harvested and fabricated product from start to finish. By the employment of every modern labor-saving device it is anticipated that guayule can be produced at a cost that will permit it to be marketed successfully in competition with rubber from other sources.

"It is said by George H. Carnahan, president of the Intercontinental Rubber Co., that the annual production of a billion pounds of crude Para rubber in the Far East requires the continuous employment of 600,000 laborers, meaning that the output of rubber per man for a year is 1,660 lb. Against this it is estimated that the same amount of guayule rubber can be produced by 40,000 men continuously employed at comparatively high wages, but utilizing every possible labor-saving device throughout the entire process of cultivation and preparation for market. This represents an annual return of 25,000 lb. of rubber per man, and the ratio of 1,660 to 25,000 is sufficient, according to Mr. Carnahan, to offset the low labor costs which apply in the East."

An Enlarged Agricultural Engineering Program for the South*

By D. S. Weaver[1]

THE great revolutions in the industries of the nation have been brought about chiefly by engineers, but the outstanding change yet to take place is that toward which we, as a group, are bending our efforts—an engineered agriculture—a change which will enable the average farm worker to enjoy the privileges and profits which should be his and which should differ in no particular from the privileges and profits enjoyed by industrial workers, except that they will be proportionately greater because of the manifold blessings which the tiller of the soil finds inherently entwined in his daily work, and which no factory worker can ever know, no matter how pleasant his working conditions.

It was not so many years ago that seventy-five per cent of our population was engaged in the primary occupation of obtaining food from the soil. Little by little that percentage has dwindled until the latest reports show only thirty per cent living in villages of five hundred or less or on farms, and it is probably not greatly in error to state that only twenty per cent are engaged in tilling the soil. With an ever-increasing number of consumers and an ever-decreasing number of producers it would seem that the efforts of the producers would be more and more highly prized by the people as a whole and that their services would be more highly rewarded. There is no doubt that this is true to some extent but until the average farm worker can command a dollar to dollar equality for his hour's work in the field or in the barn as compared to the worker in the factory or the clerk in the store, and until the farm owner receives for his investment in time, land and equipment the same sure return, dollar for dollar, as the owner of a business or the stockholder in a corporation, our task stands clearly before us. The task of assisting farmers to produce more per acre should be handled, and is being ably handled, by agricultural workers in other fields, but to us falls this far more fundamental, though only lately conceived, task of helping them produce more per worker. Making two blades of grass grow where one grew before or two drops of milk flow where one flowed before is fine, and we should lend every effort to our coworkers in other fields, but to make one man do what two (and many more) did before is our task.

In every one of the southern states there are men engaged in some form of agricultural engineering work in the employ of the state agricultural college or university, and in most of these states there are one or more men in each of the teaching, extension and research divisions. With the available man power and physical equipment each group has laid out a program of activities. With these things in common are there not several bases on which we can enlarge our programs? I will touch on just a few.

First, increased morale and financial support from headquarters. In general it is my belief that no one single factor will give the increased vigor and renewed stimulus to our work as effectively as the creation of a separate bureau of agricultural engineering in the U. S. Department of Agriculture.

Almost without exception our deans of agriculture are farm bred and reared and have a good background of farm conditions, yet I believe that in a number of cases the background is too far back. In other words, have our deans and directors ever tried to start a tractor on a cold morning? Have they ever tried to cross a modern terrace with a binder? Have they ever been faced with the necessity of complying with regulations laid down for the production of "Grade A" milk, as regards barn equipment? Have they ever wired a house and barn or installed at bathroom in their farm home? In other words are they up to the minute in their first-hand contact with farm life as it exists in 1928, or do they still think in terms of the good old days of kerosene lights and cow stables knee deep in filth? One of our biggest problems is the lack of appreciation of just what we are driving at and could do, on the part of those who have fingers on the purse strings. They are not unjust; they simply need our help in pointing out the way. Here is where some of us are guilty of neglect of duty; we are so busy with our various lines of activity that we are apt to overlook opportunities to expand by not keeping in close touch with headquarters.

Second, closer cooperation between departments of agricultural engineering. I see no reason why there should not be several cooperative projects. With so many channels in which to place our funds we ought not to duplicate efforts of workers in neighboring states. Again there should be cooperative projects with other departments in our own colleges and stations.

Third, increased contact with manufacturers whose products we are constantly using. At first thought we are apt to think chiefly of the implement manufacturers in this connection, but there are numerous others whom we may serve, while serving the farmer, and who are only too anxious to show keen interest and inject new enthusiasm in our work, such as the Portland Cement Association, the various lumber associations, clay products group, and the sheet steel industry.

Fourth, assisting and being assisted by the farm papers. The past five years have seen the addition of regular agricultural engineering columns or departments to a great many publications read by farmers, and the editors and publishers are finding ever-increasing interest in such work.

Fifth, increased publicity to our work and to farmers who are making outstanding successes, due partly at least to their adopting modern methods and modern equipment. These men are our "masterpieces" so to speak. Their use of engineering in agriculture is the goal we must set up before the rest of our farmers, and we cannot give these men too much praise as they are often true pioneers. I can give one outstanding example, living in a neighboring county to our college, who has assisted our work at the college more than any other single person in the past four years.

W. T. Moss, Youngsville, N. C., completed a one-year course in agriculture at North Carolina State College in 1913 and began farming on thirty acres of land with two mules. After enduring the hardships of most young farmers he became convinced that, if he was going to make a success of farming, he must resort to methods then unheard of in his community, and with the stimulus for reading and study which he received in his short stay at the college he began to study the implement catalogs that the various companies furnished and the desire to farm in the best sense of the word became fixed in him. With no capital but that which he had saved he set about to improve his conditions. His observation soon forced him to realize that the labor and power situation was the one on which to center his attack, although not the only one, and he has never ceased in his efforts to secure the best seed and to fertilize properly. In these respects he does not differ from hundreds of other farmers in the state, but as the years went by he became convinced that the weakness of his business and that of his neighbors lay in their use of power and machinery. Six years ago he bought his first two-horse riding cultivator, now he has six. Four years ago he bought a tractor, and he says it has earned its cost over and over. He is now equipping it for night plowing.

He farms 150 of his 225 acres and raises any crops that

*Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Memphis, Tenn., February, 1928.

[1]Associate professor of agricultural engineering, North Carolina State College. Mem. A.S.A.E.

he can handle with his equipment. His fields are not level, most of them are terraced; the additions to his original 30 acres have been at various times and his farm does not lie all in one piece. He handles his tenants in a unique way, and he freely states that the use of farm equipment has made possible his success.

Two years ago his practices were brought to our attention and he was asked to attend our annual farmer convention and give an address. His talk to the farmers was one of the high spots in the program and this past December he addressed the farm agents assembled at the college. Proper publicity given to men of his type will bring about an enlargement of our program more quickly that any other method we can devise.

The "master farmer" movement which is becoming national in its scope is paying honor to men engaged in agriculture who deserve it, and it is no less imperative that we recognize such leaders in our field. The "'master farmer" movement was inaugurated in North Carolina this year and I believe the score card worth reading here, at least that portion which deals with our work. Of the one thousand possible points three hundred and thirty-five, just about one-third, were scored on agricultural engineering phases. These points follow:

"Terracing and Drainage. (25 points) If rolling land in cultivation which needs terracing has not been terraced and land in cultivation which needs draining has not been drained, deduct 25 points. If some of the lands in cultivation which need terracing or draining have been terraced or drained, deduct from 25 points that proportion of 25 points which the unterraced or undrained lands are to the whole of the lands in cultivation needing terracing or draining. If all the land in cultivation needing terracing and draining are terraced or drained, and the proper care is being given those already built, make no deduction.

"Adequate Equipment. (45 points) In scoring on this item the tools and other equipment must be adequate for the kind of farming practiced and such as to economize man labor and cost of production. Deduct only as equipment falls short of these requirements.

"Housing. (10 points) If implements when not in use are kept under shelter where protected from the weather and other damaging influences, make no deduction. As this ideal condition is departed from deduct proportionally.

"Repair. (10 points) If such equipment is in hand, used and is kept in good repair make no deductions. If equipment, whether new and good or old and inadequate, is not kept in repair, deduct from the 10 points in the same proportion.

"Adequate Farm Buildings Conveniently Arranged. (30 points) The buildings should be adequate and suited to the kind of farming. Suitability of the buildings, or their adaptation to the needs of the kind of farming done should be given 15 points and deduction made as they fall short of the requirements of adequacy and suitability. Convenience of arrangement may be judged from two viewpoints: First, convenience of location, such as near the center of the cultivated land, to roads, the residence, etc., and, second, the convenience of location in relation to each other and convenience of interior arrangements for doing the work required. These considerations should be given 15 points and deductions made for departures from the ideal.

"Layout of Farm and Fields. (15 points) If the layout of the farm is such as to make the fields readily accessible from the buildings, regular in form and free from gullies, rocks, bushes, etc., a full score may be allowed. If the fields are small, patchy, irregular and broken by gullies, bushes, etc., severe deductions should be made. Large, regular and uniformly shaped fields, free from all obstructions to the use of large labor-saving implements reduce the cost of production and enable the farmer to cultivate more land with less cost for man labor. Topography should be considered for location of fences, roads, buildings, etc.,

"Repair and Upkeep of Buildings. (50 points) All buildings must be kept in good repair and neat and clean. Wood work should be painted.

"Condition of Fields. (20 points) Fields should be well cultivated, free from weeds, free from gullies, and wet, undrained, nonproductive spots or portions. Pastures should be free from weeds and brush.

"Maintenance of Fences, Ditches and Roads. (15 points) Fences should be ample and strong for the control of stock and deduction made for inadequate fencing for the kind of farming practiced, and for loose wires, boards, or rails and for rotten and absent fence posts. Ditches should be kept open and their banks free from weeds and brush. Good farm roads are an important aid to satisfactory farming, and rough, impassable roads either on the farm or in front of the farm should merit a deduction.

"Appearance and Condition of Yard and Lots. (15 points) This item includes condition and appearance of the barnyard and lots as well as the yard around the homes. A barn yard that is not properly drained, that is, dirty and unkempt and not adequately fenced and protected, should be severely penalized. In scoring the home yards the lawn shrubbery and flowers should be considered. A well-kept lawn, with trees, shrubbery and flowers properly set out, although it may be small, should not be penalized.

"To be convenient the home must be sufficiently large and arranged for the comfort and convenience of all members of the family. An attractive home may not be large and expensive, nor need it be elaborately or expensively furnished, but it must be tastefully furnished and have a homelike appearance. The arrangement of the rooms must be such as to conserve the health and make for the convenience of those who live and work in the home.

"Labor-Saving Equipment in House. (50 points) Waterworks, light, bath, and sewage are labor-saving conveniences which count for much. If electricity is available, vacuum cleaner, electric iron, sewing machine motor, and electric washing machine should be among the labor-saving pieces of equipment in the home."

To us as agricultural engineers, this score card of the "master farmer" can mean only two things: Either we have fallen greatly behind our coworkers in other fields of agriculture in the past, or there is an awakening in the minds of our agricultural leaders of the tremendous possibilities of our services in the future. If they, after long thought and careful analysis, assign 335 points out of a 1000 to our field, can we do aught but accept the challenge?

And what a distinct challenge to the best that we have. We are all young men; we are engaged in the youngest and at the same time the oldest phase of agriculture. Let us so enlarge our program of activities that we can meet this challenge and give to our profession its rightful place, at the top of the list of activities which are striving to enable the farmer of the South to set up and maintain a decent standard of living.

The Competition of Capital

THROUGHOUT the business world today the complaint is common that, while the volume of business is large, profits are small and uncertain. This means that, as a result of the increasing amount of capital available to the industries, their capacity has been increased until only those which are most effectively equipped and capably managed are able to make profits. Everywhere it is said that the capacity of the industries is in excess of the demand for products, but, except at brief periods, this is always true and is a sign of industrial progress. It is also true, however, that much of the capacity is not of the latest and most economical kind, but in the way of elimination. There is always profit for the low-cost producers, but the high-cost producers go to the wall as industry moves forward.

There is no competition so irrepressible as that of new capital with old. The stream of new capital which is always coming upon the market is bound to force itself into employment somewhere, and it has an advantage over the old investments in being able to utilize the very latest offerings of science and invention. In these days, when the frontiers of scientific knowledge are being extended rapidly, when the facilities for research are daily increasing, and when improvements in industry are constantly producing a flow of new capital, it may be expected that the industrial pace will be faster in every succeeding decade.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Studies on Film Accumulation in the Sprinkling Filter Bed, W. Rudolfs and D. Peterson (New Jersey Stations Report 1926, pp. 498-505, figs. 3).—Data collected on old and new film throughout one year showed fluctuations, but there is a general trend. The average amount of wet film deposited upon a tile each week weighed approximately 3.5 gm., with a variation of from 2 to 5 per cent solids. The rate of film deposit was not uniform throughout the bed in regard to total deposit, amount of solids, and percentage of ash. The older film showed a fluctuating but gradual increase in solids content from one sloughing period until the next, with an increasing percentage of ash. The action and efficiency of new and old film throughout the bed changed according to its accumulation. It is suggested that the design of a filter bed should depend on the amounts of solids to be handled.

Experimental Bacterial and Chemical Pollution of Wells, via Ground Water, and the Factors Involved, C. W. Stiles, H. R. Crohurst, and G. E. Thomson (U. S. Public Health Service, Hygiene Laboratories Bulletin 147 (1927), pp. IX + 168, pls. [4], figs. [58]).—This is a progress report of these studies, including also a Report on the Geology and Ground Water Hydrology of the Experimental Area of the United States Public Health Service at Fort Caswell, N. C., by N. D. Stearns.

In studies of the distance to which excretal pollution of soil will travel in sandy soil with slowly moving ground water, bacterial pollution with "Bacillus Coli" was recovered from well water in 1,213 samples taken under a most rigid technique at distances varying from 1 to 232 ft. away from the experimental trench in which excretal pollution was placed. Chemical pollution was recovered from well water up to 450 ft. from the same trench. Both uranin and B. coli traveled in the direction of the ground water flow, and neither was found in other portions of the experimental field. Wet weather, resulting in high ground water, was conducive to extension of the pollution, whereas dry weather, resulting in low ground water, was inhibitive of the extension and conducive to purification of the ground water. It was found that B. coli tends to localize in the upper blanket at or near the ground water table, and water samples in a given well from this blanket may show heavy B. coli pollution, while water samples a few inches lower may be B. coli negative. When the ground water falls, B. coli tends to filter out into the capillary fringe or into the soil. If the soil remains dry sufficiently long B. coli dies. Uranin appeared to float out in a blanket at or parallel and close to the ground water table, and tended to filter out into the capillary fringe and soil. However, it did not seem always to rise with higher ground water.

Experimental B coli infection of the ground water had remained alive for 2 years and 8 months when last examined, while uranin remained visible in the ground water for 2 years and 7 months.

The changes of the ground water elevations appeared to be very complex and of at least four kinds, namely, (a) the upward trend of the ground water table due to hydraulic pressure upstream, (b) the superposition of new ground water by transit from surface water downward to an old ground water table, (c) a new and higher ground water table due to a flow of new water from upstream over a former ground water table, and (d) a wave flow from upstream over a former ground water table. These movements seem to play an important part in the progression of the pollution, carrying the bacteria along to more distant points.

As polution traveled it did not appear to expand laterally but appeared to contract to narrower breadth. Under the circumstances it is considered obvious that circular cesspools have a mathematical advantage in this respect over square or oblong pits.

A mathematical analysis of the spread of pollution, as indicated by these results, leads to the conclusion that distance from points of pollution represents the great factor of safety in water supplies.

Commercial Brooder Equipment and its Operation, G. R. Shoup (Western Washington Station Popular Bulletin 2-W (1927), pp. 18, figs. 9).—This equipment is described and illustrated, and working drawings and bills of material of different parts thereof are included.

The Puyallup Laying House, Mr. and Mrs. G. R. Shoup (Western Washington Popular Bulletin 4-W (1927), pp. 52, figs. 21).—Practical information on the planning and construction of laying houses adapted for Washington conditions is presented, together with working drawings.

Distribution and Succession of Protozoa in Imhoff Tanks, J. B. Lackey (New Jersey Stations Report 1926, pp. 506-520, figs. 7).—These studies showed that flagellates are far more numerous than ciliates in Imhoff tanks. Vertically flagellates are present in maximum numbers, usually between 5 and 7 ft. There is no definitely located point for the ciliate maximum. There is as yet no proof of a well-defined seasonal succession for any of the protozoa. It was found that tanks which are not foaming have relatively small protozoan populations. The numbers of protozoa decreased to the point of defaunation in tanks which are shut off, and conversely they increase enormously if a tank runs indefinitely. Their numbers are independent of the observed ranges of H-ion concentration and temperature in the tanks. They are largely sapropelic forms so that a continuously running tank offers a constant food supply for them. There is an absolute correlation between large increases in their numbers and foaming, although no definite explanation is available for the part they take in foaming.

Imhoff Tanks, W. Rudolfs, H. Heukelekian, P. J. A. Zeller, D. Peterson and J. R. Downes (New Jersey Stations Report 1926, pp. 443-462, figs. 9).—Experiments with three Imhoff tanks are reported which dealt especially with the influence of reaction on zoological, chemical, and bacteriological characteristics.

It was found that the solids retained in the tanks increased greatly because of an effort of the operator to improve the character of the effluent. A comparison of two of the tanks, one treated with lime and the other untreated, showed that the treated tank gave no sign of foaming and was free from scum for several months in spite of the fact that it was continuously operating, whereas the untreated tank had to rest and could not be put into operation for a long time on account of heavy foaming. Gas production and composition were found to change with the operation or resting of a tank. During the first few days of operation after a prolonged resting period, methane production was the highest. Protozoa increased in direct proportion to the percentage solids increase, but bacterial numbers reached their peak before the percentage solids was highest.

Effect of Lime on Sludge Digestion, W. Rudolfs, H. Heukelekian, P. J. A. Zeller, D. Peterson, and J. R. Downes (New Jersey Stations Report 1926, pp. 412-443, figs. 12).—Studies are reported which showed that the effect of lime on sludge digestion is pronounced, influencing the flora and fauna and consequently the chemical intermediate and end products. Lime also changes the physicochemical relation in sewage solids so that the solids are differently distributed in the liquid phase with different reactions. In general, lime additions up to a certain point stimulate the numbers of bacteria, but maximum numbers do not necessarily mean maximum digestion. With higher reactions, above pH 7.6, great fluctuations in bacterial numbers occur, indicating a condition of instability. At these higher reactions the odors emanating from digesting material are stronger. The numbers of protozoa decrease markedly when the reaction of the digesting material is changed from pH 7.2 to 7.6, and higher reactions cause rapidly alternating increases and decreases. However, the variations of pH values between 7.2 and 8.8 have no limiting effect on the variety of species.

Liquefaction was found to overbalance mineralization at pH 7.2, but the reverse is true at reactions of pH 7.6 and above. The most rapid and satisfactory digestion proceeds at pH values of from 7.3 to 7.8. If the reaction of incoming fresh solids is kept at pH 7.3 to 7.6, odors are practically absent.

Daily additions of fresh solids, kept at pH values of from 7.3 to 7.6, can be increased from 2 to 3.5 per cent dry solids, and possibly to 5 per cent, reducing the relation of ripe sludge necessary for efficient digestion from 50 to 1 of fresh solids daily to 30 to 1, and possibly to 20 to 1.

Unadjusted but properly seeded material requires a per capita digestion space in summer of not less than 2.6 to 2.7 cu. ft. With reaction control this per capita effective digestion capacity can be reduced under these conditions to 1.4 to 1.5 cu. ft.

Destruction of the Khaki Weed, C. T. White (Queensland Agricultural Journal, 25 (1926), No. 6, p. 512).—The khaki weed (Alternanthera achyrantha), native of South America and said to be spreading in parts of Queensland, is reported to be easily destroyed by common salt at the rate of 1 to 2 tons per acre. A solution containing 0.2 per cent of arsenic is also indicated as effective. Hand grubbing is best in small areas.

Idaho Weeds: How to Know and Control Them, J. C. Ayres, H. W. Hulbert, and C. B. Ahlson (Idaho Agricultural College Extension Bulletin 65 (1926), pp. 73, figs. 32).—A general discussion of weeds and their control, with specific information on weeds important in Idaho.

Some Crops Subduing Weeds, V. P. Struve (Trudy Prikl. Bot. i Selek. (Bul. Appl. Bot. and Plant-Breeding), 16 (1926), No. 3, pp. 171-179; Eng. abs., p. 179).—Potatoes, summer fallow, flax, Brassica rapa, and a mixture of vetch and oats showed ability to suppress weeds in the order given during three years at the Marussino (Tambov) Experiment Station. The seeding rate and the individual development of the crop seemed of essential importance. Too thick seedings showed as many impurities as thin ones. Only

normal seedings could smother weeds. With normal seedings the weeds are subdued most effectively by crops whose growth curve parallels that of the weeds.

Housing Farm Poultry, R. T. Parkhust, P. Moore, and M. R. Lewis (Idaho Agricultural College Extension Bulletin 42, rev. (1927), pp. 38, figs. 29).—This is a second revision of this bulletin.

The Planning of Poultry Houses ([Great Britain] Ministry of Agriculture and Fisheries, Miscellaneous Publication 47 (1927), pp. 26, pls. 7, figs. 3).—Practical information is given on the planning of poultry houses adapted to conditions in England, together with working drawings, specifications, and bills of materials.

The Construction of a Laying House for Poultry (North. Ireland Ministry of Agriculture Leaflet 28, rev. (1927), pp. 8, pl. 1).—Practical information on the planning and construction of laying houses for poultry adapted for conditions in Northern Ireland is presented, together with working drawings and bills of material.

The Painting and Preservation of Poultry Buildings, W. C. Thompson (New Jersey Stations Hints to Poultrymen, 15 (1927), No. 10, pp. 4, fig. 1).—Practical information on the subject is given.

Spraying and Dusting Experiments with Weeds in 1924 and 1925, P. Bolin (Meddel. Centralanst. Forsoksv. Jordbruksomradet [Sweden], No. 303 (1926), pp. 117, fig. 1; Eng. abs., pp. 106-110).—Continued investigations in Sweden showed sulfuric acid solutions (3 to 4 per cent) to average more effective in controlling weeds in cereals than solutions of iron sulfate, sodium nitrate, or brine, or dusting with Hoefer's weed powder or calcium cyanamide. The greater average yields made by the crops sprayed with sodium nitrate solution seem largely due to its fertilizing effect. Calcium cyanamide similarly surpassed Hoefer's weed powder. Dusting was not as effective as spraying in weed control. Best results with powdered chemicals seemed to be had by dusting the crop when wet with dew, i.e., early in the morning, especially when the dewy morning is followed by a hot, sunny day.

Weeds: Their Identification and Control, M. P. Tullis (Saskatchewan Department of Agriculture Bulletin 57, 5. ed., rev. and enl. (1926), pp. 88, figs. 119).—Practical information is given regarding weed habits and on the control and eradication of annual, biennial and perennial weeds. The characteristics and illustrations of the plants and seeds of weeds important in Saskatchewan are presented to aid in identification.

Weeds of Cultivated Crops in the District of Pergamino, Buenos Aires [trans. title], L. R. Parodi (Rev. Facult. Agron. y Vet. Buenos Aires, 5 (1926), No. 2, pp. 75-171, pls. 7, figs. 19).—The characteristics and habitats are indicated for the commonest weeds in cultivated crops in the district of Pergamino, northwest of Buenos Aires. The weed flora in the flax and wheat seed are described, with a determinative key to the weed seeds, based on structure.

General Discussion on the Effect of Lime on Sludge Digestion, W. Rudolfs, H. Heukelekian, P. J. A. Zeller, D. Peterson, and J. R. Downes (New Jersey Stations Report 1926, pp. 489-498).—Data obtained at the station are summarized and discussed, indicating that in the effect of lime on digestion several factors are of more or less importance, including its effect on the activities of microorganisms, chemical reactions induced, and the change in the physical condition of the digesting material. The effect on the activities of microorganisms may be to make the medium more favorable for acid producing organisms, to induce the establishment of a predominantly different flora, or to make the medium less or more favorable for protozoa. Chemically lime affects the organic and mineral acids and, under certain circumstances, favors the liberation of ammonia. Physically it flocculates the finely divided materials, changing the viscosity and affects the surface tension of the liquid.

Separate Sludge Digestion Tank Experiments, W. Rudolfs, H. Heukelekian, P. J. A. Zeller, D. Peterson, and J. R. Downes (New Jersey Stations Report 1926, pp. 463-480, figs. 11).—Experiments in a separate sludge digestion tank with a capacity of 25,000 cu. ft. are reported, and the results compared with those obtained in an Imhoff tank.

On the assumption that at least 100 days sludge storage capacity is required for Imhoff tanks, the covered separate sludge digestion tank did as well as a good working Imhoff tank. It appeared that the reaction of the contents of a tank can be controlled with a greater degree of accuracy in separate sludge digestion tanks, and that the daily addition of definite quantities of fresh solids to ripe sludge is simpler. It is easier and more economical to apply heat to a separate sludge digestion tank than to an Imhoff tank.

Amounts of Lime Necessary for Adjustment of Fresh Solids and Material in Digestion Tanks, W. Rudolfs, H. Heukelekian, P. J. A. Zeller, D. Peterson, and J. R. Downes (New Jersey Stations Report 1926, pp. 481-489, figs. 6).—Data are presented to show the amounts of lime necessary to adjust the reaction of incoming fresh solids of different concentration, and examples are given for the correction of poorly working acid tanks.

Comparative Tests of Radiator Finishes, W. H. Severns (Journal American Society of Heating and Ventilating Engineers, 33 (1927), No. 1, pp. 23-28, figs. 3).—Studies conducted at the University of Illinois are reported from which the conclusion was drawn that a certain standard radiator with a certain standard finish must be made the basic standard of comparison for tests of radiator finishes.

It was found that the color and chemical composition of the finish pigments and the vehicle used to carry the pigments of the basic finish must be defined if results are to be useful. The color of the pigment is apparently not so important as the chemical composition of the finish pigments and the vehicle used to carry them. It was further found that the reduction of the heat transmitted by a radiator coated with aluminum bronze is not as much as 25 per cent, as widely reported for all classes of radiators, but that it may range from about 18 per cent for special and very effective radiators down to 9 per cent or less for wider and higher column type steam radiators.

Flow of Water Through Porous Concrete, W. C. Kirchoffer (Water Works, 66 (1927), No. 9, pp. 351-354, figs. 9).—Experiments on the loss in head when water is passed through porous concrete are reported, from which conclusions are drawn as to the type of concrete slab which will make a good substitute for well screens and for pipe manifolds and strainers in filter bottoms.

The results indicate that for well screens clogging is apparently overcome, for filter bottoms washing may be done satisfactorily without injury to the filters and that in general porous concrete is well adapted for such uses.

Gaseous Explosions, IV, V, G. G. Brown and G. B. Watkins (Industrial and Engineering Chemistry, 19 (1927), No. 3, pp. 363-369, figs. 5).—The fourth and fifth contributions to the subject from the University of Michigan are presented.

IV. Rate of rise of pressure, velocity of flame travel, and the detonation wave (pp. 363-366).—Velocity of flame travel and rate of rise of pressure are shown to be similar and to vary in the same way with changing initial conditions. Detonating mixtures of pure liquid fuels and substantially theoretical oxygen were exploded with various amounts of nitrogen in the constant volume bomb. The amount of nitrogen necessary to reduce the intensity of the detonation to an arbitrary standard was found to vary directly as the rate of rise of pressure. The conclusion is drawn that the rate of rise of pressure upon the explosion of a fuel mixture is the major factor indicating the tendency of that fuel mixture to set up the detonation wave in a progressive homogeneous reaction, and that engine knock is not due to a detonation wave as recognized in progressive homogeneous explosions.

V. The probable mechanism causing "detonation" in the internal combustion engine (pp. 366-369).—It was found that if the maximum rate of rise of pressure as determined in a progressive homogeneous reaction under constant initial conditions be divided by the autoignition temperature on the absolute temperature scale, a number is obtained which varies directly as the knocking tendency of that particular fuel in an engine. This fact suggests that rate of rise of pressure and autoignition temperature are the two factors determining the tendency of fuels to knock in an engine, and that autoignition of the unburned mixture adiabatically compressed against hot surfaces is the mechanism causing fuel knock in an internal-combustion engine.

Study of Sewage Settling Tank Design, C. H. Capen, Jr. (Engineering News-Record, 99 (1927), No. 21, pp. 833-837, figs. 5).—Studies are reported the results of which indicate that the majority of settling tanks are inefficient, the efficiency being reduced by the presence of excessive amounts of sludge and scum. The most efficient tank has been found to be one with an even distribution of flow at both inlet and outlet ends, both being preferably submerged and arranged symmetrically. The depth of the tank apparently has little effect on the the efficiency. Long, narrow tanks are not generally as good as those with a ratio of length to width of between 4 to 1 and 5 to 1. Baffles can be helpful but are more often detrimental than useful. Velocity has been found to be an important factor in design, although high accidental velocities due to sludge accumulation may be harmful.

Two-Year Record of Farm Service, R. Boonstra (Electrical World, 90 (1927), No. 12, p. 568, fig. 1).—An analysis of electrical energy consumption and connected loads on 2,297 Illinois farms is graphically presented.

Book Review

"Electricity on the Farm and in Rural Communities" is the title of a new 136-page bulletin published by the Committee on the Relation of Electricity to Agriculture, 1120 Garland Building, Chicago, Illinois, as "C.R.E.A. Bulletin," Volume IV, No. 1. This bulletin is a summary of the results of investigations conducted in twenty-four states during the past four years and presents a digest of all information on the subject of rural electrification at the command of the Committee. At the beginning of the bulletin are featured the men who have been largely responsible for rural electric developments, and a brief review of the organization for handling the rural electric problems. The book contains 210 illustrations, 83 tables, and other information on rural uses for electricity, including cooking, laundry, refrigeration, and other household applications; farm lighting; water supply; dairy applications; ensilage cutting; grain and forage grinding; incubation and brooding; lighting for egg production; hay hoisting; grain elevating; irrigation; stationary spray plants; insect control; dehydration of fruits; threshing, etc. The price of the bulletin is 50 cents each, postpaid.

AGRICULTURAL ENGINEERING

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Unofficial Publicity

RECENTLY there has appeared in certain newspapers and trade journals forecasts on agricultural matters purported to have been made by officials of this Society. For example, one such article states that as a result of a study of the rice harvest in the Sacramento Valley a forecast of cheaper rice has been made by officials of the Society. As another example, several newspaper clippings from newspapers in various parts of the country that have been received quote the Society as making a forecast respecting grape production.

It is not the policy of the Society to make such forecasts, or to authorize persons to use its name in making them. Needless to say, therefore, the two news stories referred to were not only unauthorized but were given out without the knowledge or permission of Society headquarters.

The activities and achievements of the Society merit a great deal of publicity, and the organization is glad to receive publicity that carries a true statement of its achievements and attitude on various agricultural problems, but any publicity that is not approved by the officers of the Society and does not conform to Society policy is not only not official but may misrepresent our attitude on various questions and create an unfavorable reaction that would be detrimental to our interests.

The proper province of the Society as regards publicity is to confine itself to news of its activities as an organization and of achievements in the field of engineering as applied to agriculture. The forecasting of agricultural conditions and developments in general is indulging in a type of speculation with which the agricultural engineer is not in sympathy. There is so much about which to tell the public in the field of actual achievement in agricultural engineering, and which is a much more potent factor in arousing interest and creating greater favorable recognition for our profession, that there should be no occasion for indulging in forecasts that might be misleading or prove a stumbling block to the agricultural engineer and this Society.

Members of the Society will render a real service, if they will use their influence wherever possible to create favorable and truthful publicity and help curtail the enthusiasm of those who would put out publicity that is not based on facts or that would react unfavorably to the Society and to our profession.

In the Limelight

NEVER before has the profession of agricultural engineering and the national society which represents it been so much in the public eye as during the past year. In newspapers, in farm papers, in business publications, in the general magazines of the first order have appeared a large number of articles on engineering in agriculture, the authors of which are, for the most part, members of the American Society of Agricultural Engineers. Not only has the general subject of the application of engineering to agriculture been covered in considerable detail in such articles, but the part which the Society is playing in that development has also been prominently featured.

These articles have been of tremendous educational value to the general public. As a result there is gradually coming about a greater general appreciation of what the agricultural engineer can do and is doing for the benefit of the agricultural industry.

Commenting editorially on the personal interview which representatives of this Society had with President Coolidge last summer, the New York "Times" made this significant statement:

> "We have had all kinds of volunteer authorities on agriculture along with societies that took a little interest in the land but a great deal more in politics, so that it is a refreshing novelty to hear such words of truth and soberness as the agricultural engineers spoke to the President."

This is a splendid tribute to the attitude of agricultural engineers on agricultural problems. The sane, sensible viewpoint is the outstanding characteristic of the articles that have appeared in the press under the authorship of members of the Society. The agricultural engineers do not claim to have at their command the cure-all for agricultural ills. They recognize the place and importance of other branches of agricultural science. All they ask is that the place and function of engineering be recognized in the solution of agricultural problems, and that agricultural engineers be given an opportunity to make their contribution to the advancement of the industry they serve.

The Society desires to give every encouragement to its members to continue the preparation of constructive articles dealing with the progress and achievements in agricultural engineering and the contribution it is making to increased efficiency and prosperity in agriculture.

A Large Field

UNQUESTIONABLY one of the greatest potential fields for agricultural engineering development in this country is in the southern states. Probably in no other section is there a greater need for the agricultural engineer. The agricultural engineering phases of flood control, the complete mechanization of the cotton crop, changed conditions resulting from shifting of centers of agricultural production—to mention but a few—all involve engineering problems of the greatest importance.

The recent meeting of the Southern Section of the American Society of Agricultural Engineers at Memphis served to emphasize to a much greater extent than ever before the pressing importance of the problems with which the agricultural engineer is confronted in this particular section of the country. The real situation and needs of the section have not been fully appreciated, but such meetings as the recent one at Memphis bring into clearer view what our fellow members in the South are facing.

Certainly the South is a most inviting field agriculturally. Far-sighted business farmers are appreciating more and more the tremendous agricultural possibilities which the South possesses, and many leaders of agricultural thought have from time to time indicated that the future of agricultural development in the South is little dreamed of at the present time. It is a region which possesses many advantages for certain branches of agricultural production which have not been generally recognized.

The agricultural engineering profession will do well to keep its eyes on the opportunities which the South has to offer.

A.S.A.E. and Related Activities

Southern and Southwest Sections Hold Joint Meeting

A JOINT meeting of the Southern and Southwest Sections of the American Society of Agricultural Engineers was held at the Hotel Peabody, Memphis, Tenn., on February 1 and 2, in conjunction with the annual meeting of the Southern Agricultural Workers Association held there at that time. Nearly fifty members and visitors attended the combined section meetings, practically every state in the South being represented.

The agricultural engineering and the home economics sections of the Southern Agricultural Workers Association combined their meetings for the presentation of two papers, "Modern Home Equipment and Home Economics," by Miss Eloise Davison and "The Present Trend of Rural Electrification in the South," by E. C. Easter. These subjects were of great interest to both groups. During the mornings the agricultural engineers attended the general meetings of all agricultural workers of the South, at which problems of interest to all agricultural workers in this section were presented and discussed.

At the first afternoon session papers on several phases of agricultural engineering of pressing importance to southern agriculture were presented. Miss Eloise Davison, head of the home economics department of the National Electric Light Association, and E. C. Easter, agricultural engineer for the Alabama Power Company, presented their papers during this session.

E. B. Doran, agricultural engineer, Louisiana State University, showed a film taken during the flood of the Mississippi. His discussion brought out clearly the great problem confronting this flooded area, and the country as a whole, as regards control measures. A. F. Whitfield, president of the Clover Fork Coal Co., Kitts, Ky., presented a paper describing his very interesting experiment in silt control, a method he has developed for collecting silt from flowing streams and depositing it for agricultural purposes.

Deane G. Carter, agricultural engineer of the University of Arkansas, in a paper on "Economics of Farm Structures in a Southern Livestock Program," brought out some well taken points on farm building construction and planning. His paper was followed by one on "An Enlarged Agricultural Engineering Program in Southern Land Grant Colleges," by D. S. Weaver, agricultural engineer, North Carolina State College of Agriculture and Engineering.

The evening program on February 1, which was presented for the entire group of southern agricultural workers, was devoted to two addresses, one by Miss Eloise Davison, "The Twentieth Century Home," and the other "The Contribution of Engineering to Agricultural Success" by Col. O. B. Zimmerman, president of the American Society of Agricultural Engineers, followed by two interesting films.

On Thursday afternoon, February 2, the session was devoted entirely to farm machinery. H. B. Walker, senior agricultural engineer, U.S.D.A., presented a paper on "Cooperative Research in Farm Machinery." It was followed in order by "The Southern Section A.S.A.E. Farm Machinery Program," a paper of great interest to the Section, by M. L. Nichols, agricultural engineer, Alabama Polytechnic Institute. "Labor and Power Cost Studies in Producing Cotton" was the title of a paper by J. T. McAlister, agricultural engineer, Clemson College, which brought out interesting results of a year's work at that institution.

One of the great problems confronting agricultural engineers and all other southern agricultural workers is that of the harvesting of the cotton crop. The following three papers relating to this problem were presented for discussion: "Mechanical Harvesting of Cotton in Northwest Texas," by W. M. Hurst, Division of Agricultural Engineering, U. S. Department of Agriculture; "Development of Mechanical Cotton Harvesters," by Chas. Berry, Berry Cotton Picker Co., Greenville, Miss., and "Economic Factors in the Use of Machinery in the Harvesting of Cotton in the Eastern Seaboard States," by S. P. Lyle, University of Georgia.

The last and one of the most timely of the papers was that presented by J. T. Copeland, extension agricultural engineer, Mississippi A. & M. College, on "A Farm Machinery Extension Program for the Southern States." E. G. Welch, extension agricultural engineer, University of Kentucky, led the discussion of this paper.

A business meeting of the Southern Section was held late in the afternoon. The officers elected for the coming year are: Chairman, S. P. Lyle, agricultural engineer, University of Georgia; vice-chairman, J. B. Kelly, agricultural engineer, University of Kentucky, and secretary, D. S. Weaver, agricultural engineer, North Carolina State College of Agriculture and Engineering. Resolutions regarding flood control measures and the establishment of a Bureau of Agricultural Engineering were passed by the Section.

At the banquet in the evening Col. O. B. Zimmerman, president of the American Society of Agricultural Engineers, and L. J. Fletcher, agricultural engineer, Caterpillar Tractor Company, were the principal speakers.

Hearings on Wyant Bill

THE Wyant Bill (H.R. 8127), introduced in the House of Representatives December 20, 1927, was referred to the Committee on Expenditures in the Executive Department. This bill provides for the transfer to the Department of the Interior of the public-works functions of the federal government. The tentative dates for hearings on this bill have been set for March 12 to 14, 1928. This bill provides for the transfer to the Department of the Interior the Bureau of Public Roads of the U. S. Department of Agriculture and other public-works functions of the government. Of particular interest to agricultural engineers is that the bill specifically excepts the agricultural engineering division of the Bureau of Public Roads in the transfer of that bureau to the Department of the Interior.

C.R.E.A. Bulletin on Rural Electrification

A REVIEW of the new 136-page bulletin on rural electrification just published by the Committee on the Relation of Electricity to Agriculture will be found on another page of this issue. Under the able direction of Dr. E. A. White, director, and Lee C. Prickett, assistant director of the Committee, there has been produced in this bulletin the most comprehensive work on the application of electricity to agriculture and rural communities that has ever been published. All who are interested in any way in rural electrification will want copies of this splendid bulletin.

It will be of interest to members of the American Society of Agricultural Engineers to know that of the forty-five men who have played a prominent part as project leaders and field engineers in rural electrification, and mentioned in the new C.R.E.A. bulletin, thirty-six of this number are members of the Society.

For Fighting Corn Borer

REPRESENTATIVE PURNELL of Indiana has introduced into Congress a bill calling for another appropriation of $10,000,000 to continue the fight on the European corn borer. There is every indication that the campaign against the corn borer so effectively started last season will be pushed even more aggressively this year.